

UNIVERSITY OF BRISTOL.



THE ANNUAL REPORT

OF THE

Agricultural and Horticultural
Research Station

(THE NATIONAL FRUIT AND CIDER INSTITUTE)

LONG ASHTON, BRISTOL,

1930.

BATH:

PRINTED AT THE CHRONICLE AND HERALD PRESS, WESTGATE STREET.

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CONTENTS.

	PAGE
INTRODUCTION	B. T. P. Barker 7
FRUIT CULTURE:—	
Progress Report on Fruit Breeding	G. T. Spinks 13
Apple Root Stock Investigations	G. T. Spinks 19
A Preliminary Report of the Raspberry Variety Trials at Long Ashton	T. Swarbrick 27
The Influence of the Position of the Top Bud of the Scion upon the Stand of Grafts	T. Swarbrick 46
Some Effects of Bark Ringing on the Composition of Fruit Trees	T. Wallace, V. L. S. Charley and J. O. Jones 52
Preliminary Observations on the Nitrogenous Materials in Apples during Storage	M. Pilling and W. H. Pearsall 62
PLANT PATHOLOGY:—	
Examination of Plants for Insecticidal Principles :	
II. Elecampane	F. Tutin 71
Notes on some Agricultural and Horticultural Pests in the Bristol Province :	
I. The Beet Carrion Beetle (<i>Blitophaga opaca</i>) and its Control	L. N. Staniland and C. L. Walton 72
II. A Case of Sainfoin Midge (<i>Contarinia Onobrychidis</i> , <i>Kieff</i>) in Wiltshire	L. N. Staniland and C. L. Walton 74
III. Notes on a Serious Tomato Pest (<i>Scutigerella</i> <i>Immaculata</i>)	C. L. Walton 76
Observations on Capsid Bug Control by means of "High Neutral" Tar Distillate Washes in 1930.	L. N. Staniland and C. L. Walton 79
The Control of Capsid Bugs on Black Currants :	
Progress Report	L. N. Staniland, F. Tutin and C. L. Walton 95

CONTENTS—contd.

PAGE

The Raspberry and Loganberry Beetle and its Control.	
Further Experiments with Pyrethrum Emulsion	
Sprays and a Dust	C. L. Walton 100
A Note on the Control of Woolly Aphis on dormant Nursery	
Stock	L. N. Staniland and C. L. Walton 106
The Control of <i>Galerucella Lineola</i> —A Major Pest of Willows..	
	H. P. Hutchinson and H. G. H. Kearns 108
The Control of <i>Phyllodecta Vitellinae</i> L. (Chrysomelidae)—	
A Major Pest of Willows	H. P. Hutchinson and H. G. H. Kearns 112
Progress Report on Vegetable Diseases	L. Ogilvie and B. O. Mulligan 127
A Fruit Rot of Apples and Pears due to a Variety of <i>Phytophthora</i>	
<i>Syringae</i>	L. Ogilvie 147
Spraying Trials against Apple and Pear Scab at Long Ashton :	
III. Season 1930	R. W. Marsh 151
Apple Scab Control in the Bristol Province :	
Field Trials, 1930	R. W. Marsh 162

CIDER :—

Cider Making Trials for the Season 1929-30	O. Grove 175
Cider Making Trials with Nova Scotian Apples	O. Grove 192
The Effects of Storage Temperature on Cider—II	O. Grove 195
The Clarification of Ciders by the Centrifuge Method—I	
	B. T. P. Barker and O. Grove 199
The Prevention of Deposit Formation in Perries	O. Grove 205
Apple Juice Concentrates	O. Grove 209

WILLOW CULTURE :—

The Production of Cricket Bat Timber	H. P. Hutchinson 215
--	----------------------

ADVISORY AND EDUCATIONAL SECTION :—

Report on Advisory Work, 1929-30	220
--	-----

PUBLICATIONS DURING 1930	230
----------------------------------	-----

INTRODUCTION.

BY B. T. P. BARKER, DIRECTOR.

By reason of new developments, abnormal working conditions due to the meetings of the British Association at Bristol and those of various Imperial and International conferences held in this country in 1930, the number and variety of overseas and other visitors to Long Ashton resulting from the latter, and important staff changes, the year 1930 stands distinct from any of its predecessors in the history of the Department. Two changes radically affecting the character of the Department call for mention at the outset on account of their important bearing on working arrangements. They are the reorganisation of the work hitherto carried on at the Campden Research Station, and the alterations affecting the agricultural advisory work necessitated by the resignation of Professor J. A. Hanley, the Chief Agricultural Advisory Officer.

THE CAMPDEN STATION.

After prolonged negotiations with the Ministry of Agriculture and other Government Departments concerned, a new scheme for dealing with the various sides of the work on the preservation of fruit and vegetables centred at Campden has been approved and is now in operation. Under this scheme the Campden Station in future will be concerned solely with research and advisory work relating to the canning of fruit and vegetables in its commercial aspects, the other sections of its work under the old scheme being transferred elsewhere as indicated below.

A new feature affecting the financial arrangements for the Campden Station has been imposed by the Treasury as a condition attached to the annual Government grant. The commercial canning industry in this country is to be called upon to bear a part of the cost of upkeep of the station in future. Assistance and advice will only be rendered by the staff to those engaged in the canning industry who become annual subscribers. It is satisfactory to be able to record that the total subscriptions so far promised already exceed the minimum sum stipulated by the Treasury. The new arrangement in respect of the Campden Station itself is fixed for a five-year period, at the end of which the

future of the station will be decided in consultation with the Government Departments concerned and the canning industry. Until that time the station remains a part of the Department of Agriculture and Horticulture of Bristol University, with Mr. F. Hirst, M.Sc., as Resident Director, under the general direction of the Head of the Department.

The work relating to the domestic side of the preservation of horticultural produce will be carried on as heretofore by Miss Margaret L. Adams, but her headquarters have been transferred from Campden to the Research Station at Long Ashton. The annual summer courses of instruction, given by her hitherto at Campden, will be held in the immediate future under her direction at the Royal Agricultural College, Cirencester, which is already associated with the University of Bristol for degree courses in agriculture.

In addition, the staff at Long Ashton has been strengthened by the appointment of Mr. V. L. S. Charley, B.Sc., to a newly created post for research and advisory work on fruit and vegetable products other than canned goods. This will enable the limited investigations on that subject previously included in the Campden programme to be extended.

THE BERKELEY SQUARE ADVISORY CENTRE.

The second radical change in the Department affects the Berkeley Square Agricultural Advisory Centre at Bristol most closely. On his appointment as Professor of Agriculture at Armstrong College, Newcastle, last July, Professor Hanley resigned his positions as Chief Agricultural Advisory Officer of the University in charge of the Berkeley Square Centre and Principal of the Royal Agricultural College, Cirencester. Following discussion between the University and the Governing Body of the College, it was decided to discontinue this dual appointment. Accordingly, Mr. A. W. Ling, M.Sc., has been appointed to succeed Professor Hanley as administrative officer at Berkeley Square, while still retaining his position there as Adviser in Agricultural Chemistry. He will, in addition, be responsible for the advisory work in general agriculture. To relieve him of some of the routine duties of the old post, an Assistant Agricultural Chemist, Mr. R. D. H. Round, B.Sc., (Leeds University) has been added to the staff.

During the year the Berkeley Square staff has been strengthened also by the creation of two further new posts. Mr. J. E. Blundell, M.Com. (Birmingham University), has been appointed Permanent Assistant in Agricultural Economics, and an extension of the work

in this subject has thus been made possible. Mr. W. D. Menzies, M.R.C.V.S., has been selected for the second post, that of Veterinary Advisory Officer. He is at present finishing a special course of study in France and is due to come into residence at the beginning of May next. For a long time the need of an advisory officer in this subject has been greatly felt; in view of the many live-stock problems inevitable in an agricultural area of the character of the Bristol Province. The additional grant made by the Ministry of Agriculture for this purpose should be more than justified by the gain to the farmers of the Province through the reduction of live-stock losses due to disease.

There has also been a change in personnel in the Dairy Bacteriology staff at Berkeley Square, Mr. C. A. MacEacharn being succeeded by Mr. C. S. Miles, N.D.D., as Dairy Bacteriologist.

THE LONG ASHTON STATION.

At the Long Ashton Research Station, apart from the staff increase already referred to in connection with the Campden rearrangements, the principal change in staff has been brought about by the departure of Mr. J. G. Maynard, M.A., who has held the post of Pomologist since 1924. The vacancy thus created has been filled by the transfer of Mr. T. Swarbrick, M.Sc., Ph.D., from his previous post of Plant Physiologist, and the appointment of Miss Elsie S. Smyth, Ph.D., to the latter as his successor.

To supplement the work of the Advisory Mycologist and enable the investigations on the control of diseases of asparagus and other vegetable crops in the important market garden areas of the Bristol Province to be extended, provision has been made by the Ministry of Agriculture for the appointment of an Assistant Mycologist. Mr. J. W. Ewan held that position for a short period in the first instance, and was then transferred to the Ministry of Agriculture staff. Mr. B. O. Mulligan has been appointed as his successor.

Arrangements have been made also for an extension of the investigations of the station on insecticides. This has been made possible by a special grant from the Colston Research Committee of the University, which has allocated for that purpose the income from the Mardon benefaction. For a period of one year in the first instance, Mr. J. Bloom, Ph.D. (Leeds), has been awarded a post-graduate studentship to carry out the investigations under the supervision of Mr. F. Tutin, and will begin his work early in 1931.

The unusually numerous Imperial and International Conferences associated with agriculture and horticulture held in this country

during 1930 affected the normal working arrangements of the Department to a considerable extent. The annual meetings of the British Association were held in Bristol during September. Between June and August there were also held in London and elsewhere in this country the International Entomological Conference, the International Botanical Conference, and the Imperial and International Congresses on Horticulture. At all of these the Institute was represented by the attendance of various members of the staff and at each, except the International Entomological Conference, one or more papers were contributed by its representatives.

These meetings also resulted in the influx of an unusual number of visitors to Long Ashton. In the case of the British Association, separate organised parties from the Agricultural, Botanical, and Physiological Sections visited the station. A party of over 120 members of the International Horticultural Congress, representing in all over 30 different countries, also paid a visit. Throughout the summer large numbers of individual visitors from all parts of the world, attending the various Conferences, journeyed to Long Ashton to inspect the work in progress, some extending their visits over several days.

Among other visiting parties during the year mention should be made of one of representatives of overseas Dominions attending the Imperial Conference. It included the Rt. Hon. J. W. Forbes, Premier of New Zealand; Dr. A. C. D. Rivett, Chief Executive Officer of the Australian Department of Scientific and Industrial Research; and Dr. E. Marsden, of the corresponding Department for New Zealand.

During a considerable part of the busiest season of the year, therefore, there was an almost constant call on individual members of the Staff to give such visitors the required attention. At the same time there is no question that the contacts thus established with workers in other parts of the world will more than justify the expenditure of time and attention involved, and will prove of ultimate benefit to the work of the station. In fact this result is already apparent in several instances.

In spite of these abnormal calls the usual round of visiting parties suffered little disturbance. The following list records the organised parties received at the station during the year:—

- Cider Makers from Monmouth, Dorset and Worcester.
- Surveyors' Institution.
- Cheltenham Growers' Club.
- Bristol-French Week Visitors.
- Bradford-on-Avon Gardeners' Association.

Bristol Education Committee's Gardening Class.
 National Cider Institute (Open Day for Members).
 Evesham and District Market Gardeners' and Fruit Growers' Association.
 International Horticultural Conference.
 Great Western Railway Workers' Welfare Union.
 Messrs. W. D. & H. O. Wills' No. 3 Factory Welfare Committee.
 British Association (Agricultural, Botanical and Physiological Sections).
 Staffordshire County Agricultural Education Committee.
 Port of Bristol Authority Staff Association.
 Studley Horticultural College Students.
 Colston School Scientific Society.
 Bristol University Mathematics Club.

The Annual Tasting Day on Thursday, May 1st, 1930, proved again a highly successful function. The attendance was probably a record one and was estimated at over 1,500. A feature of the day's proceedings was an address by the Rt. Hon. Lord Noel-Buxton, at that time Minister of Agriculture and Fisheries. He also distributed the prizes to the successful competitors in the Cider Competition Scheme.

During the year the services of members of the staff of the Institute have been in frequent request for lectures to meetings of farmers, scientific associations, and other bodies. Educational work of this type has been supplemented by exhibits at several agricultural and other shows, including the following:—

Royal Horticultural Society's Spring Show, Chelsea.
 Bath and West Society's Show, Torquay.
 Three Counties Show, Worcester.
 Wilts County Show, Trowbridge.
 Norfolk Horticultural Show, Norwich.
 Gillingham and Shaftesbury Show, Gillingham.
 Melplash Agricultural Society's Show, Bridport.
 Cheltenham Floral Fete, Cheltenham.
 Swindon Allotment Holders' Show, Swindon.
 Abergavenny Horse Show, Monmouth.
 Imperial Fruit Show, Leicester.
 Brewers' Exhibition, London.
 The Gloucester Federation of Women's Institutes Produce Exhibition.
 The Oxford Federation of Women's Institutes Produce Exhibition.
 The Warwick Federation of Women's Institutes Produce Exhibition.

Close collaboration with research workers at several other institutions has been maintained as in other recent years.

Each year also sees an extension of the system of field experiments conducted on growers' farms and fruit plantations, and at other suitable centres in various parts of the country. By this means the results obtained in the field under the local conditions at the Research Station are being tested under more varied circumstances and are being applied to commercial conditions. The thanks of the Station are due to all who have provided the necessary facilities: in many cases the personal help given by them has made the successful development of this branch of the work possible.

Acknowledgment too must be made to various post-graduate and other research workers for participation in investigations associated with the research programme of the Station. By means of their help problems which otherwise could not have been given attention have been dealt with.

Special reference should be made to the striking advance in the volume of advisory work undertaken during the year. Past records have shown a continuous increase in the advisory service of the Department, but on no previous occasion has the number of enquiries advanced to the same extent.

In conclusion, a word of special appreciation for the efficient services rendered by the assistant staff is due. On both the administrative and the technical sides ready help from them throughout a year of unusual strain has been forthcoming.

PROGRESS REPORT ON FRUIT BREEDING.

BY G. T. SPINKS.

Breeding work with the various fruits has again consisted in the observation and selection of existing seedlings and in the raising of new families. In the case of top-fruits it now seems possible to recommend a few varieties for commercial trial, though these varieties have as yet been tried only on the smallest scale. However, these fruits possess many good qualities, and it is thought that they may be desirable additions to the varieties which are at present available to fruit-growers. It is only by trial on a large scale under different conditions of soil, climate and culture that their ultimate value can be ascertained.

Amongst the bush fruits there are a number of very promising seedlings, but most of these are being subjected to cropping trials for a few years before they are recommended for commercial use.

New families of the different fruits come into bearing each year and fresh seedlings are continually being selected for propagation and further trial. Some of the most promising of the older seedlings are now being used as parents in the raising of fresh families.

The work on the various fruits is dealt with in more detail under separate headings below.

Apples.—Crops were obtained this year from about 300 individual seedlings, but, on the whole, the fruit was rather uninteresting. A considerable number of the fruiting trees were members of two families which were the result of crossing a sweet cider variety with a dessert and a culinary apple respectively. When all the members of these families have fruited they may yield some information on the inheritance of sweetness and acidity, but none of the fruit appears to have any practical utility. Many of the other fruits represented the remnants of older families of seedlings, including those obtained from open-pollinated seed of known varieties. A smaller proportion of the fruit was obtained from newer families, while crops were also borne by trees which had previously been selected for propagation. It was decided to propagate 4 new varieties for trial and another 12 varieties were noted for further observation, while about 200 seedlings were discarded.

Up to the present time 22 seedling varieties have been propagated for more extensive trial. Five varieties which have now been under observation for several years appear to be worth a commercial trial and a brief description of them is as follows:—

- (1) Dessert, early September, medium to smallish, round: colour, golden with bronze red flush and stripes: flesh slightly yellow, crisp, juicy: sweet but brisk, slight Cox flavour. (Allington Pippin $\times$ Star of Devon.)
- (2) Dessert, mid-September, medium size, rather flat: almost covered crimson, sometimes very deep colour: flesh cream, crisp, juicy: sweet, good flavour. (Devonshire Quarrenden $\times$ Cox's Orange Pippin.)
- (3) Dessert, mid to late September, medium to large, rather flat: covered moderate or very dark crimson: flesh slightly yellow, crisp, juicy: sweet, slight briskness, fair flavour: heavy. (Cox's Orange Pippin open-pollinated?)
- (4) Dessert, September to early October, medium to rather large, round: partly covered with bright crimson flush and stripes: flesh slightly yellow, often tinted with pink, crisp, juicy: sweet, moderately brisk, fairly good flavour, refreshing: consistently good cropper. (Wealthy open-pollinated.)
- (5) Dessert, October to November, medium size, round: extensive dull crimson flush and stripes: flesh slightly yellow, crisp, fairly juicy: sweet, good flavour of Cox type. (Cox's Orange Pippin open-pollinated.)

It is hoped that other varieties which have been propagated may justify their recommendation for commercial trial in succeeding years.

The pollinations noted in the last Report resulted in the production of the following seedlings:—

- (1) Mackintosh Red $\times$ late seedlings of good flavour: two families of 83 and 37 plants.
- (2) Early, highly coloured, acid seedling $\times$ highly-coloured sweet seedling: two families of 53 and 59 plants.
- (3) Smaller families of other crosses and selfs.

Pollinations performed this year were confined to selfs and intercrosses of seedlings and had as their object the production of fruit with the qualities of (1) earliness, colour and flavour, (2) lateness, colour and flavour.

Pears.—About 60 seedlings bore fruit this year, but it appeared to be an unfavourable season for observations on pears. Owing, probably, to weather conditions, many trees dropped their crops badly before the fruit was mature and in other cases the quality of mature fruit was inferior to that recorded for the same trees in previous years. Nevertheless, 4 fresh seedlings were selected for propagation and 4 others for future observation: it was decided to discard 20 seedlings. In previous years 6 varieties had been propagated and, of these, one seems definitely to be worthy of commercial trial, its description being briefly as follows:—

Dessert, mid to late October, medium or large, pyriform or conical: pale golden colour with slight flush, partly covered smooth golden-brown russet: flesh slightly yellow, melting, very juicy: very sweet and good flavour: tree vigorous, open habit but not drooping, consistently good cropper. (William's Bon Chretien $\times$ Conference.)

With the object of producing a good quality pear of later season and with a good cropping capacity, the above selected variety was this year self-pollinated and also crossed with Doyenne du Comice and with another seedling variety which is late in season. The second seedling was also selfed and crossed with Doyenne du Comice. The self-pollinations produced very few seeds, but a large number were obtained from the crosses.

Plums.—Fruit was obtained this year from about 70 seedlings, many of which had fruited before. It was decided to propagate two fresh varieties for trial and to discard 10 inferior seedlings. As stated in a previous Report, a considerable number of seedling plums have borne fruit of good quality, but the small crops hitherto borne by some varieties raise doubts concerning their commercial value. Of the 20 seedlings which have already been propagated, however, the varieties described below appear promising as regards both quality and weight of crop.

- (1) Dessert, late August, medium size, roundish oval: golden, almost covered or spotted with red, much bloom: flesh yellow, very juicy: very sweet, good gage flavour. (Heron open-pollinated.)
- (2) Dessert, late September, fairly large, oval: pale red colour on yellow ground, yellow dots, bloom: flesh yellow, rather hard, very juicy: very sweet, good gage flavour. (Jefferson $\times$ Victoria.)
- (3) Dessert, late September, large, oval, slightly narrowed at stem end: golden, few red spots, sl. bloom: flesh yellow, very juicy: sweet, good flavour. (origin ?)

- (4) Culinary, late September to early October, medium size, roundish oval: dark purple blue, bloom: flesh greenish yellow, juicy, acid: cooks very well, giving deep red colour: will hang very late on the tree. (Merry-weather Damson $\times$ Cox's Emperor.)

Several selected seedlings were self-pollinated this year. In four cases a very good set of fruit was obtained, in two cases only a moderate set, while in one case no fruit resulted from the pollination. A second generation of plants will be raised from the seeds.

Black Currants.—The year 1930 was a good one for black currants and the trial plot of selected seedlings gave a good crop, considering that the bushes were small and cropping for the first time. Crop weights were taken from the triplicated units of 24 bushes of each variety in the plot, including Baldwin and Boskoop.

The dates on which the different varieties were ready for picking were noted and it was found that several seedling varieties were earlier than Boskoop, others were later than Baldwin, while the rest were intermediate in season.

It is obviously impossible to obtain a true idea of the cropping capacity of a variety from the crop weights of one year, and especially from a young plantation bearing its first crop. The records, however, possibly give some indication of the relative productiveness of the varieties in the future. The variety Boskoop gave a poor crop which was exceeded by almost all the seedling varieties, but it is probable that the performance of Boskoop will improve in course of time. There are two strains of Baldwin included in the trial, one of which gave a moderate crop while the other bore a good crop. It was found that 17 seedling varieties bore heavier crops than that of the inferior Baldwin, two seedlings produced heavier crops than the better strain of Baldwin, while three more seedlings equalled the latter.

The majority of the seedlings produced fruit of good size and quality which realised good prices, for the season, on the market. Indeed, it appeared that the seedlings, on the whole, produced a sample of fruit which was superior to that obtained from other blocks of standard varieties in our plantations. Crop records and other observations must be continued for two or three more years before a reliable estimate of the relative values of the seedlings can be obtained, but the above results suggest that a few varieties may have a decided commercial value.

A family of seedlings raised a few years ago from a cross between Baldwin and an unnamed variety resembling Boskoop was again

observed this year. No plants of an outstanding character were noted, but five seedlings are being propagated for a further trial: all the other seedlings in the family have been discarded.

Raspberries.—The records of the commercial raspberry variety trial plot for the last four years show that one seedling variety is one of the heaviest cropping varieties on the plot: it is also one of the earliest in season, but the small size of the fruit is against its success as a commercial variety. This variety, however, was used as a parent two years ago and crossed with other heavy-cropping early varieties: the resulting seedlings have grown strongly and will bear their first crop in 1931.

A second seedling variety is also a heavy cropper and although the fruit is small its firmness and bright colour may give it some value as a variety for canning and bottling. A third variety was planted out in quantity only two years ago, and as the plants got a bad start, owing to dry weather following planting, they yielded only a poor crop this year. It is thought that this may prove to be the best of the above three varieties, as the fruit is of a large size.

Several families of seedlings have been under observation for the last three years, and as they carried good crops this year it was possible to make a selection of plants for propagation and to discard the rest. A number of plants bore heavy crops of good fruit and material for propagation was obtained from 30 seedlings and has been planted out to form a small trial. These 30 selected varieties represent three families, of which one parent in each case was Norwich Wonder and the other parent was Royal, Baumforth A and Bath's Perfection respectively.

Blackberries.—Crop weight records were taken this year from plants representing five clones of selected seedling blackberries. Two of the clones contained only small numbers of plants and perhaps little reliance can be placed on their crop-weight figures, but one of the two appears to be definitely inferior to the other four clones and can probably be discarded. The other three clones are indistinguishable from each other, though they originated from separate seedlings. In the case of one clone half the plants are at the top of a slope and bore double the crop of the other half of the plants, which are about 200 yards away, at the bottom of the slope. Hence there is probably no significant difference between the weights obtained from the three clones. The average weight of fruit picked from each plant ranges from 13.5 lbs. in the case of the plants at the bottom of the slope to 29.5 lbs. from those at the

top. The other two clones yielded crops intermediate between these two figures. The fruit is large and of good quality and appearance. A small quantity of fruit was ready for picking on August 11th, 1930, and picking was continued until September 23rd. It appears probable that these selected blackberries could be recommended for growing commercially.

Strawberries.—The families of strawberry seedlings which cropped in 1929 were again observed this year. Owing to lack of ground at planting time the plants were very crowded in 1929, especially as they had grown very vigorously, and at the end of the year approximately half the plants were removed from the bed. As far as possible alternate plants were discarded, but the most promising plants were left in every case. Consequently in 1930 the plants had more room, but in spite of this the crop, as a whole, was much inferior to that of the previous year. However, most of the plants which had already been propagated still showed their superiority, and an additional 35 plants were selected for propagation. The young plants obtained from runners in 1929 made very vigorous growth but were not allowed to fruit; further runners were taken from them in order to obtain larger clones for trial.

The families of young seedlings obtained from pollinations in 1929 were planted out and have made good growth: they will bear their first crop in 1931.

The only seed obtained this year was the result of crossing an unknown French variety with Royal Sovereign and with Stirling Castle. The unknown variety was chosen as a parent on account of its vigour and the apparent resistance of its tough, dark green leaves to pests and diseases: it is also a good cropper, though the fruit is not of a desirable type.

APPLE ROOT STOCK INVESTIGATIONS.

BY G. T. SPINKS.

In previous Reports accounts have been given of the preliminary stages of an investigation into seedling apple root stocks. It now seems desirable to summarise the results already obtained in the succeeding, or trials, stage of the investigation.

OBJECTS OF THE TRIALS.

The object of the trials may be classified as follows :—

- A. The comparison of seedling and vegetatively propagated stocks.
- B. The grouping of seedling stocks and the evaluation of common effects within the group, if any, on scions.

This part of the investigation includes enquiries into the following points :—

- (a) The continuity of the morphology of the root systems.
- (b) The discovery of improved stock types.

The trials now in progress are conveniently considered under two headings :—(1) Layered Stocks, (2) Seedling Stocks.

(1) LAYERED STOCKS.

In the Report for 1917 an account was given of studies of the root systems of a large number of seedling stocks. As a result of that examination the stocks were divided into classes, each of which seemed to have a characteristic type of root system. At the same time it was found that a number of stocks showed signs of producing adventitious roots very readily, and it was thought that they could probably be propagated by layering. A selection of stocks was then made containing several representatives of each class, most of those chosen being also apparently likely to root freely. In all, about 60 stocks were selected for further study.

The Report for 1925 contains an account of the attempts which were made to propagate the selected stocks. It was found that some were only propagated with difficulty, and these were discarded, while others were rejected on account of their thorny character, which made them unsuitable for nursery operations.

It was decided that 17 of the most promising stocks should be propagated and used in trials when worked with standard scion varieties. (This number has since been reduced to 15). As each stock was, after its selection, simply one individual plant, a number of years were required in which to establish productive stool-beds of each stock. It was not, therefore, until 1923 that enough young plants of each stock were available for working to provide material for trial plots of trees.

All the stocks have been propagated by the layering system, and each year since 1923 there has been a good supply of rooted layers which have been planted in the nursery and worked with market varieties of apples.

Trial Plots.

The laying out of satisfactory trial plots has been a matter of some difficulty. A trial consisting of a sufficient number of trees on each of the 15 root-stocks occupies a considerable area of land, particularly in the case of standard trees, even if only one scion variety is used. The land available at the Research Station for trial purposes is very limited, and it has therefore been necessary to set out extension trial plots at various centres in the surrounding counties. This was desirable in any case in order to test the stocks under different conditions, especially as regards the soil. Through the co-operation of various fruit-growers it has been possible to plant trial plots both in the form of commercial cultivated plantations and of grass orchards.

A list of the trial plots which have already been set out is given below. It will be seen that in some cases there are only a few stocks in a trial and also that the number of trees on a particular stock is small. This is due, firstly, to the small size of some of the available plots and, secondly, to the fact that in the earlier years of propagation of material the number of trees of a particular variety that were worked was not sufficient to allow for casualties in the nursery. It is obvious that reliable deductions cannot be drawn from the performances of any one of these small-scale trials, but they should be useful in checking the results of larger trials, and the combined results of all the trial plots should provide reliable information on the relative performances of all the stocks. It should be noted that almost every plot contains comparable trees worked on Malling Type II or Type XII stocks to act as standards of comparison: in some cases both these types are included in the same trial.

Details of Trial Plots.

The following brief details in Table I show the composition of the

plots which have already been planted, the ages indicating the ages from the bud of the trees at the end of 1930 :—

TABLE I.

	Location of Trial.	Scion Variety.	Form of Tree.	No. of Stock Types	No. of Trees on each Stock	Age in Years
1	Long Ashton ..	Worcester Pearmain	Bush	13	8	6
		James Grieve ..	"	11	8	6
		Lane's Prince Albert	"	16	8	5
2	Gloucestershire	Worcester Pearmain	"	6	8	4
3	Worcestershire	James Grieve ..	"	6	10	4
		Laxton's Superb ..	"	17	10	2
4	Worcestershire	Worcester Pearmain	"	17	10	3
5	Worcestershire	Worcester Pearmain	"	10	10	3
6	Long Ashton ..	Worcester Pearmain	Standard	6	10	6
		Newton Wonder ..	"	8	10	6
		Blenheim Orange ..	"	9	10	6
7	Long Ashton (grass)	Worcester Pearmain	"	5	5	7
		Worcester Pearmain	"	7	8	4
		Bramley's Seedling	"	7	8	4
		*Unworked Stocks ..	"	7	8	5
8	Worcestershire (grass)	Worcester Pearmain	"	5	5	7
9	Gloucestershire (grass)	Newton Wonder ..	"	9	5	5
10	Somerset (grass)	Worcester Pearmain	"	6	4	5
11	Somerset (grass)	†Unworked Stocks ..	"	3	6	5

The trees in trials 7-11 are being grown in grass orchards.

*To be head-worked with Bramley's Seedling.

The root-stocks are the same age as those on which comparable budded trees are growing.

†To be head-worked with Kingston Black.

Further supplies of trees now in the nursery will be available for planting out to form additional trial plots in succeeding years.

On the plot of bush trees at Long Ashton records are being kept in some detail, including measurements of girth, annual shoot growth, weight of prunings, number of blossom trusses, and number and weight of fruits. On all the other trial plots records will be confined to annual measurements of girth, and height and spread of the tree, and observations on blossom, quantity and quality of fruit, crop weights, and any distinctive qualitative differences in the trees.

Data Obtained and Conclusions Reached.

The lifting of trees from the nursery has afforded opportunities for examining the roots of trees of two to five years of age, and of weighing trees of those ages, while the growth of trees in the nursery and on the trial plots has also been the subject of observation and measurement. These observations lead to certain conclusions, which are set out below, though they are as yet only tentative.

(a) Types of Root-Systems.

In 1917 it was thought that the seedling stocks examined could be divided into classes, designated A to J, according to the relative amounts of fibrous and coarse roots present. The plants in class A were said to have a mass of fine fibrous roots, with practically no coarse roots; class B was very similar, but the roots appeared slightly coarser. Classes C, F and G consisted of plants with horizontal lateral roots, the coarseness of which increased from C to G, while the amount of fibre decreased. In classes D and E there were numerous lateral roots, all with a more vertical tendency than in C, F and G: the roots in class E were said to be coarser than those in D. Plants of classes H and J were distinguished by a marked absence of adventitious roots, the other roots probably resembling those of F and G.

This classification had to be made by eye alone, since no measurements or weights of fibrous and coarser roots could be taken from the single original plants available.

The roots of all trees on the selected stocks have been examined as the trees were lifted from the nursery, but here again the examination had to be merely by inspection. In most cases no attempt was made to lift the trees with their root-systems complete, and the longer roots were therefore cut off by the spade. It will be evident that only a rough idea of the relative amounts of fine and coarse roots present has been obtained; but even such an inspection has served to bring out the following facts:—

Five stocks classified as A or B have been under trial, but it has been found that none of the trees on those stocks exhibit the characteristics originally noted in classes A and B. All the trees examined have had strong roots of the F type, though in some cases there has been some tendency to fairly vertical rooting of the D and E type. It now seems probable that the original classification was based on the type of root-system produced by the plants as the result of being dug up and replanted a year or two before examination. The masses of fine roots which were observed in the original plants were young adventitious roots, and no coarser roots had at

that time been formed. The character which led to the stocks being placed in classes A and B was, in fact, not the presence of many fine roots and the absence of coarse ones, but the ability of the stock to produce a large number of small adventitious roots. When the stock is allowed to grow undisturbed a few of these roots develop into coarse roots, and the root system of the older tree no longer shows a large proportion of fine roots.

The one stock of class D included in the trials has fairly consistently produced roots which would now be classified as F.

Two stocks of class E still agree fairly well with the original classification, of which the main feature was the downward tendency of the roots. Sometimes the roots appear to be more horizontal in habit, and it has been noticed that one of the stocks when worked with the variety James Grieve has distinctly horizontal roots. This influence of scions of James Grieve on the root-stocks on which they are worked has been noted in other cases.

No stocks of class C have been propagated, but 4 of class F and 3 of class G are being tried. All these stocks have produced roots of the F or G type and as the difference between these classes consists almost entirely of the relative amount of fibre it is almost impossible, by rough methods of inspection, to decide whether some trees should be classified as F or G. One stock in the G class, however, appears to have definitely less fibre than any of the others.

Classes H and J are not represented in the stocks under trial, as they could not readily be propagated. It is probable that they differed from classes F and G only in their inability to form adventitious roots.

The above observations show that the range of differences in the types of root-system on trees of ages between 2 and 5 years is not as great as that originally found on the young seedlings, and judging from the roots of these trees the stocks under trial now appear to fall into the classes E, F and G. In all the above cases the roots examined have been those of stocks which have been worked with a scion variety, and no unworked stocks have been examined after growing undisturbed for several years; but it appears unlikely that the type of root has been modified to any extent by the scion variety, as any one stock has almost always shown the same type of root-system regardless of the scion variety worked on it. One exception, that of a class E stock affected by James Grieve, has, however, been referred to and it is possible that other scion varieties which have not yet been used might have an effect on some of the stocks.

Any more accurate classification of the stocks would appear to

involve the careful lifting of complete roots and the weighing or measuring of the various parts of the root-systems.

(b) *Correlation of Root Type and Stock Effect.*

The trials of these stocks have not yet been in progress long enough to enable reliable conclusions to be drawn on the subject of stock effect, but the data already collected provide some indication of the performances of the various stocks. Numerous measurements have been made on trees in the nursery, trees have been weighed when moved from the nursery to the trial plots, and various measurements and observations have been made on the established plots. Taking all these data into consideration, but without attempting any statistically accurate analysis, the following conclusions have been drawn :—

None of the stocks have a very decided dwarfing effect, *i.e.*, anything comparable to the effect of Malling Type IX.

Several stocks appear to be approximately equal in vigour to Malling Type II.

Four or five stocks induce very vigorous growth, but it is not yet certain whether any of them are as strong as Malling Type XII. All these stocks are now placed in classes F and G, though two of them approach class E in character. Probably the strongest stock is the one which definitely falls into class G.

None of the stocks equal Malling Type II as regards earliness of the age at which they cause the production of blossom and fruit. One of the strongest stocks appears to approach most nearly to Type II in this respect. Almost all the stocks are more precocious than Type XII and most of the strongest are markedly so. No correlation has yet been found between precocity and root type.

Two stocks appear to encourage an upright habit of growth in the branches of the trees : both fall into class F, with horizontal roots.

One stock (in class F) has been very irregular in its performance : in some cases it has produced strong trees, but on one plot almost all the trees are very weak. On this plot very bad patches of soil occur, potash is markedly deficient, and water-logging is widespread, and it is possible that the stock is particularly susceptible to these conditions. On this plot also the trees on this stock showed a very decided purple colour in the leaves early in the autumn. The small quantity of fruit which has yet been produced by trees on this stock in different plots all appeared to be more highly coloured than the fruit from trees on other stocks.

From the above observations it is concluded that no clear correlation is yet evident between root type and performance of the tree.

(c) *Practical Utility of the Stocks.*

At this early stage of the trials it is not possible to gain much information concerning the practical value of the stocks, or, at all events, to decide whether any of them are superior for any purpose to those already in general use.

It is obvious that none of the stocks have a very dwarfing effect similar to that of Type IX and it is as yet uncertain whether any have advantages over well-known stocks of the semi-dwarfing or strong types.

There are indications that some stocks may have the advantage of combining vigour with a capacity for earlier bearing than that usually obtaining in strong stocks.

Some time must elapse before the standard trees on the various layered stocks can be compared with similar trees growing on seedling stocks in the same plots.

From the point of view of the stock propagator and nurseryman there is not a great deal of difference between the various stocks. The number of rooted shoots obtained by layering is satisfactory in each case, though some stocks are better than others. Almost all the stocks produce very well-rooted shoots, the number of roots being least on the strongest stock in class G : in spite of the scarcity of roots, however, the layers of this stock establish themselves in the nursery very well, though they are liable to suffer if planting is followed by a very dry period.

There is a very decided difference in the ease with which rooted layers of the various stocks can be removed from the layered plant by pulling. Most of the stocks produce layers which are clean and convenient for working, though in several the layers are inclined to be slightly spined or branched. No differences have been noted as regards ease of working, or the percentage "take" of buds or grafts on the various stocks.

It would be difficult to select any of the stocks as being decidedly superior or inferior as regards propagation or in connection with operations in the nursery.

(2) **SEEDLING STOCKS.**

The trials of seedling stocks referred to in the Report for 1925 are proceeding. The seedlings used for one batch of trees were "free"

stocks obtained from seed of unknown origin, but other sets of trees were worked on seedlings from single varieties of crabs and other apples. In each case the seedlings were graded for size and root type before being planted in the nursery.

The following trial plots have already been planted out :—

- (1) Long Ashton : 80 seedlings from various known parents : bush trees of Stirling Castle.
- (2) Long Ashton : 51 "free" seedlings.
20 Hampshire Crab seedlings.
15 layered Stocks of one strong variety for comparison.
All these are standard trees of Bramley's Seedling.
- (3) Gloucestershire : 63 Hampshire Crab seedlings : standard trees of Bramley's Seedling : grass orchard.
- (4) Gloucestershire : 50 Hampshire Crab seedlings : standard trees of Bramley's Seedling : grass orchard.

The trees in these trial plots will be observed for several years in order to determine the degree of uniformity or difference produced by the seedling stocks. The bush trees of Stirling Castle will probably have yielded all the information likely to be obtained from them in another year or two, but it will be some time before decided results are obtainable from the standard trees.

Additional batches of standard trees on other varieties of seedlings are now in the nursery, and it is hoped to find suitable plots of ground on which they can be planted for trial in succeeding years. The last set of seedling stocks which it is proposed to test were planted in the nursery at the beginning of 1930 and were budded in the summer. These are seedlings from the seed of very old trees of *Malus acerba* growing wild in Ireland. This species is reported to produce very vigorous seedlings, and it will be interesting to find whether the trees worked on the stocks are correspondingly vigorous.

A PRELIMINARY REPORT OF THE RASPBERRY VARIETY TRIALS AT LONG ASHTON.*

BY THOMAS SWARBRICK.

During the normal course of the investigations proceeding at Long Ashton, it was realised that commercial stocks of raspberries were often mixed and that the nomenclature of varieties was extremely variable. A single variety was found growing under several names, while a stock growing under a single name might often contain several very distinct varieties. This question of varietal mixture and nomenclature was under examination at the Research Stations of East Malling and Long Ashton as early as 1922. A note on the "Impurity of Raspberry Stocks" was issued by N. H. Grubb and G. S. Peren as a joint publication from the two Stations (1). At the same time, Grubb (2) published a paper upon "Commercial Raspberries and their Classification." This latter publication gives descriptions of most of the better varieties known at that time. The above classification and selection carried out by Grubb and Peren forms the starting point of the present series of variety trials under commercial conditions, although during the course of the trials the selection and classification have been continued.

The importance of having unmixed stocks commercially and experimentally is self evident. It is undoubtedly true that many of the older mixed plantations are being grubbed and that varieties such as Lloyd George, Red Cross and Pyne's Royal, stocks of which are usually fairly true to name, are now being planted.

In conjunction with Grubb at East Malling, true stocks of varieties have been collected at Long Ashton, and after certain preliminary observations upon the quality of the berries, general habit of growth and disease susceptibilities, the more promising ones were included in the present trials. Varieties which suffered from some serious drawback such as very poor fruit quality were eliminated during the preliminary trial period.

*This work was started in 1925 by Mr. J. G. Maynard and was continued by him until 1929-30. Since Mr. Maynard has relinquished his appointment at Long Ashton, it has fallen to the present writer to collect together the data and present it in its present form. A preliminary account of the trial by Mr. Maynard, prepared in 1929, has been of considerable help, and acknowledgment in respect of this is due to Mr. Maynard. Acknowledgment is also due to Mr. Thompson who has collected many of the data and given much assistance.

It should be pointed out that during the years since 1925 some varieties originally planted have been removed as they were not considered of sufficient merit for continued trial. Other varieties have been added to the plot as the spaces have become available.

It will be seen from the plan in Figure 1 that each variety is planted in units. Each unit consists of 21 stools of the particular variety, planted as single canes at 18in. apart in the rows. A gap of 5ft. to 8ft. is left between each unit in the rows and the rows are 12ft. apart. It will be seen that the above units of varieties occur either three or six times in a random distribution over the plot, except in the case of some unnamed seedlings referred to under an index letter and number, which often only occur once. These latter are not discussed in this paper.

In spite of the relatively wide planting distance between the rows considerable difficulty has been experienced in keeping the varieties from becoming mixed by the underground development of spawn. Frequent deep forkings and cultivations have been necessary between the rows, but in spite of this procedure, some of the more vigorous varieties have quickly spread from row to row, and have been a considerable source of trouble on this account. It is realised, of course, that deep cultivation should be avoided as much as possible in raspberry cultivation, but under the conditions of this trial it has been necessary for the above reason. The difficulty of keeping the varieties from becoming mixed in the above way will probably be the main factor limiting the useful life of the trial. For extended variety trials over long periods it would appear that this factor should receive special consideration.

Cultivations and Manuring.

With the exception of the above deep digging and forking the cultivations have consisted of a shallow winter ploughing towards the rows and as many disc and spring-tine cultivations during summer as were necessary.

The manuring has been rather unusual. No bulky organic manure has been applied to these raspberries either before or since planting. The manures have consisted of inorganic fertilisers applied in spring each year as follows :—

1924-25	..	Nil.		
1925-26	..	1½ cwts. Nitrate Soda.	3½ cwts. Superphosphate.	
		2 cwts. Sulphate Potash.		
1926-27	..	2 cwts. Nitrate Soda.	2½ cwts. Superphosphate.	1 cwt.
		Steamed Bone Flour.	2½ cwts. Sulphate of Potash.	
1927-28	..	2 cwts. Sulphate of Potash.		
1928-29	..	2½ "	"	
1929-30	..	2½ " Nitrate Soda.	2¼ cwts. Sulphate Potash.	

All the above are rates per acre.

These have been worked into the ground by the usual spring cultivations.

The treatment of the canes has been as follows. In the spring following planting the cane was cut down to one good bud above ground level.

The question of the amount of cane to remove in subsequent years was a problem since the quantity of cane produced by the different varieties varied widely. The general problem of cane thinning in order to obtain maximum yields of best quality fruit is outside the scope of the present trials, but one which obviously needs investigating. The cane thinning each year has consisted only in the removal of all weak and damaged canes up to the year 1929-30. During that winter a somewhat more drastic thinning plan was employed in an attempt to increase the weight of crop per fruiting cane. A light tipping of the canes has been carried out in spring each year. The old fruiting canes are removed as early in autumn as conveniently possible.

During the fruiting season the canes are supported where necessary by lengths of string tied to posts at each end of the units.

Several colonies of bees have been situated near the site of these trials, and it has been noticed on several occasions that the flowers are visited frequently by these insects.

General Varietal Notes and Descriptions.

In Table I are set forth very briefly various notes concerning each of the varieties in the present trial. The method of presentation is convenient for the purposes of rapidly comparing the relative merits of varieties. It is not intended to discuss the varieties under the headings given in Table I. The data are set out in this way so that general comparisons may be made among the varieties with ease and comparative rapidity, and serve as a convenient source of reference and as an introduction to the varieties under discussion in this report.

TABLE I.

Variety.	CANE AND ROOT.					FRUIT.					Season.
	Average Comparative Height of Cane (cms.)	Need of Supporting Fruiting Canes.	Root Spread.	Disease.	Size.	Shape.	Colour.		Plugging	Flavour.	Firmness.
							Pale or Deep.	Bright or Dull.			
Baumforth A.	155.5	Needed	Medium	Nil	Medium	Round	Medium	Bright	Medium	Sharp	Med.-Soft
Baumforth B.	144.0	Needed	Medium	Anthracnose fairly bad, some mosaic	Medium	Conical	Medium	Dull	Good	V. Sweet	Medium
Baumforth E.	117.0	Not neces- sary	Small	Mildew bad ; some mosaic	Medium	Round	Pale	Bright	Medium	Sharp	Medium
Lloyd George	134.7	Needed	Very great	Some mosaic	Very large	Conical	Deep	Dull	Good	Medium	Medium
Readers Perfection	161.0	Needed	Medium	Anthracnose bad	Medium	Conical- round	Medium	Dull	Medium	Inspid	Medium
Semper Fidelis D.	132.5	Needed	Medium	Nil	Medium	Conical	Deep	Dull	Bad	Sharp	Squashy*
Hornet A.	100.0	Not neces- sary	Small	Mosaic	Large	Conical	Deep	Dull	Good	Sweet	Medium
Hornet D.	160.0	Needed	Great	Nil	Small	Round	Deep	Dull	Few large drupelets which break	Sweet	Breaks
Herbert	142.0	Needed	Great	Nil	Large	Round	Medium	Bright	Medium	Sharp	Medium
Maclaren's Prolific	130.0	Needed	Medium	Nil	Medium	Conical	Medium	Medium	Difficult	Sharp	Medium- squashy
Goliath	170.0	Needed	Great	Mosaic bad	Small	Round	Deep	Dull	Few large drupelets which break	Medium- sharp	Breaks
Pyne's Royal	126.0	Not neces- sary	Small	Mosaic	Very large	Conical- round	Medium	Medium	Good	Sweet	Medium
Improved Beehive	139.0	Needed	Medium	Nil	Small	Round	Medium	Bright	Good	Medium- sharp	Firm
Duke of Cornwall	130.7	Needed	Medium	Mosaic	Large	Round	Medium	Dull	Good	Sweet	Firm
Red Cross	144.0	Needed	Medium	Mosaic	Large	Conical	Deep	Dull	Good	Sharp	Medium
Devon	135.0	Needed	Medium	Mosaic.	Medium	Round- conical	Medium	Dull	Medium	Medium	Firm
Norwich Wonder	125.0	Not neces- sary	Small	Nil	Large	Conical- round	Deep	Dull	Good	V. Sweet	Medium
North, Fillbasket	140.0	Seldom necessary	Small	Mildew	Medium	Round	Medium	Dull	Good	Sweet	Firm
Parsons Fillbasket	170.0	Needed	Medium	Nil	Small	Round	Pale	Bright	Medium	Inspid	Soft

RESULTS OF CROP TRIALS.

(a) *Total yield of Fruit per group of six units over the four year trial period, 1927-1930.* It is not intended at this point to give a serious statistical analysis of the data so far accumulated upon the crop yields, but rather to concentrate attention upon the general features of the varieties under trial with a view to selecting varieties suitable for commercial cultivation. The commercial value of a raspberry seems to depend upon such factors as easiness of picking, firmness and size of berry, dessert quality and flavour, equally as much as upon total crop yield. It will become evident later that the varieties which have cropped most heavily in these trials are not necessarily the ones which can be unreservedly recommended for commercial culture on a large scale.

With the above object in view, namely to evaluate varieties from a commercial cultural standpoint, certain records were not taken in the early years which would be necessary for a satisfactory statistical analysis of the yield data. Similarly, where only three units of a variety are present on the plot, the total yield of these three units has been doubled so as to make possible a direct general comparison of total yields.

Considering first the total crop weight produced by the varieties in groups of six units, the data are given in Tables II and III. Where only three units of a variety have been on trial the crop of these has been doubled so that a direct comparison between all the varieties is thereby possible.

The yields for each variety for each of the years 1927 to 1930 inclusive are given in Table II. In this table the varieties are listed each year in the descending order of crop yield. In this way it is possible to see at a glance the way in which varieties have fluctuated in yield from year to year. This fluctuation in yield from year to year is reflected in the relative positions the varieties occupy in the lists.

It is interesting to notice that the five or six leading varieties have maintained a fairly steady position towards the head of the lists each year. There have been, however, one or two notable exceptions. These are seen in the 1930 crop weights. The variety Pyne's Royal, which in the preceding years has been near the bottom of the lists, has in 1930 risen to occupy the fourth position from the head of the list. The case of Baumforth A is the reverse of that of Pyne's Royal. This former variety, which has been well towards the head of the lists in the years 1927-1929 has fallen to the tenth place in 1930. It will be seen later, however, that this variety has given a very high average yield over the four year period.

The main points brought out by Table II are as follows :—

1. Certain varieties are always towards the head of the lists, although they may occupy slightly different positions each year. Two exceptions to this are noted in 1930, when Pyne's Royal rises to near the top and Baumforth A sinks down to the tenth position.

2. The heaviest cropping year is the second year of cropping. In each subsequent year—two only having been as yet under observation—the crop falls off in total yield. This point will be taken up again later, since it is interesting to notice that during this time the total number of fruiting canes is increasing, but the total crop is decreasing. The yield per cane is clearly decreasing year by year as the stools grow older.

TABLE III.

Showing Total Crop of each Variety over the Four Year Period—1927-30. The Crop per Acre is calculated from the Crop yielded by 126 Canes planted in 30 yards row run. Commercial Plant taken as 2ft. by 6ft.

Variety.	Total Crop 1927-30 in grams.	Total Crop per acre calculated from yield in grams.	Calculated Average Crop per acre 1927-30 approx.	Average Yield per year expressed as % of highest yield.
		Tons. Cwts.	Tons. Cwts.	
Improved Beehive ..	386150	11 10	2 17	100
Lloyd George ..	360567	10 14	2 13	93
Baumforth A. ..	320647	9 10	2 8	84
Herbert ..	267104	7 18	1 19	68
Parsons' Fillbasket ..	257566	7 14	1 19	68
Hornet A. ..	255221	7 12	1 18	67
Red Cross ..	253613	7 10	1 18	67
Duke of Cornwall ..	249651	7 8	1 17	65
Maclaren's Prolific ..	249309	7 8	1 17	65
Norwich Wonder ..	236392	7 0	1 15	61
Semper Fidelis D. ..	234503	7 0	1 15	61
Reader's Perfection ..	211653	6 6	1 11	54
Hornet D. ..	208748	6 4	1 11	54
Baumforth B. ..	193900	5 16	1 9	51
Pyne's Royal ..	178260	5 6	1 6	46
Devon ..	144594	4 6	1 2	39
<i>Varieties Grubbed</i>				
1929-30.				
Goliath ..	246884	7 6	2 9	86
Northumberland Fillbasket ..	168612	5 0	1 13	58
Baumforth E. ..	134726	4 8	1 9	51

Table III sets forth the total yield of the varieties over the four year period. This table shows not only the actual yield in grams obtained from the six units used in these trials, but it also gives the calculated yields *per acre*, using the yields of the six units as the basis for the computation. It is admitted that to calculate yield per acre from such a small unit as 30 yards run of row may introduce a fairly large error. In the present case the yield per acre has been calculated upon the following basis. Assuming that a commercial plant of raspberry canes is two feet apart in the rows and six feet apart between the rows, there are 3,630 canes required per acre. In the six units used in the present trials there were 126 canes planted, which is approximately one-thirtieth of 3,630. Hence to get yield per acre from the yield of the six units, the yield was multiplied by 30 and converted into pounds from grams. The yield per acre is calculated and given in this way since it relates the yields to the areas and weights of normal experience. During the remaining part of this paper the yields discussed will be those calculated to tons per acre.

An examination of Table III shows that the three varieties, Improved Beehive, Lloyd George and Baumforth A have yielded much better than the others. They have given total yields of 11 tons 19 cwt., 10 tons 14 cwt. and 9 tons 10 cwt. respectively. This gives an average yield per year over the four years of 2 tons 17 cwt., 2 tons 13 cwt. and 2 tons 8 cwt. respectively. For general purposes these three varieties may be regarded as having cropped well over 2 tons per acre per year for a four year period. This of course is an extremely satisfactory performance.

Eight varieties, namely Herbert, Parsons' Fillbasket, Hornet A, Red Cross, Duke of Cornwall, Maclaren's Prolific, Norwich Wonder and Semper Fidelis D form a group which have yielded between 7 and 8 tons per acre over the four year period. They range in average crop per year from 2 tons per acre in the case of Herbert, to 1 ton 14 cwt. per acre in the case of Semper Fidelis D. There is therefore a range in crop of about 5 cwt. per acre per annum among the 8 varieties of this group. These varieties have also given a fairly creditable performance.

It will be noted from Table III that the variety Pyne's Royal occupies the position next to the bottom with an average yield of 1 ton 6 cwt. per annum. This is less than half the average crop of Improved Beehive over the same period. This inferior position of Royal should be interpreted with caution. It is a variety which appears to be slow to establish itself, and appears to have suffered somewhat from the manurial treatment given to these plots. Under the conditions of this trial the cane is short and the variety gives

evidence of requiring more generous nitrogenous manuring than has been accorded to these plots. It is a mid-season to late variety, and bears large fruits of very desirable dessert quality. It will be seen later that the variety comes out very well indeed in the lists when the varieties are grouped according to crop yield per fruiting cane. The desirability of this variety will be touched upon again later.

It will be noted from a consideration of Table III that the varieties Goliath, Northumberland Fillbasket and Baumforth E were discarded from the trials after three years cropping. Baumforth E was eliminated because it is invariably somewhere near the bottom of the lists, the fruit is of poor colour and quality generally. It is a variety very subject to mildew and does not seem worth growing under Long Ashton conditions. Northumberland Fillbasket cropped better than Baumforth E, but the size of the fruit is so small and the variety like Baumforth E is extremely susceptible to mildew. The general combination of these factors render the variety of doubtful value for commercial culture. The variety Goliath is in slightly different case since in the three years cropping it is always near the top. In 1927 the first year of cropping it was actually on top. Its fruit, however, is small and of very poor colour. The main disadvantage of this variety, however, is the extreme way in which the drupelets break away from each other in picking. Even when picked under satisfactory conditions the sample presents a very bad appearance due to the broken fruits and poor colour. Goliath, although a good cropper, does not appear worth growing because of these very serious drawbacks, and in view of these the variety has been eliminated from the trials.

(b) *Yield of Fruit per Fruiting Cane of each Variety.* In Tables IV and V are given the data relating to the crop produced each year per fruiting cane.

Two main points are brought out by the data given in Tables IV, V and VI. They are, first, with the notable exceptions of Pyne's Royal and Red Cross which will be discussed a little later, the varieties that are at the head of the list of total crop performance (Table III) are also at the head of the list when the varieties are classified, upon the basis of average crop per fruiting cane. In other words these varieties are high yielders because they produce a high average yield per cane.

The second point brought out very clearly in Table V, is that the yield per fruiting cane has very markedly fallen off each year of cropping. Although the data are not given it should be pointed out that the number of fruiting canes has been increasing year by

TABLE IV.
Showing the Average Crop per Fruiting Cane. In Each Year the Varieties are Listed in Order of Merit.

1927.	Grams.	1928.	Grams.	1929.	Grams.	1930.	Grams.
Improved Beehive	312.7	Pyne's Royal	151.9	Improved Beehive	83.75	Red Cross	89.3
Goliath	294.6	Improved Beehive	127.1	Baumforth A.	74.55	Lloyd George	82.2
Red Cross	291.2	Hornet A.	122.3	Duke of Cornwall	71.2	Pyne's Royal	75.6
Pyne's Royal	252.7	Baumforth A.	121.0	Red Cross	65.06	Hornet A.	69.4
Baumforth A.	243.6	Red Cross	116.6	Northumberland	..	Improved Beehive	66.1
Herbert	240.0	Lloyd George	114.0	Fillbasket	63.51	..	..
Lloyd George	238.0	Northumberland	..	Hornet A.	61.19	Duke of Cornwall	55.9
..	..	Fillbasket	113.2	Semper Fidelis D.	57.24	Maclaren's Prolific	44.8
Duke of Cornwall	202.2	Herbert	109.3	Norwich Wonder	53.12	Norwich Wonder	44.5
Semper Fidelis D.	197.7	Duke of Cornwall	105.6	Goliath	51.94	Baumforth A.	44.2
Hornet A.	184.9	Semper Fidelis D.	97.8	Lloyd George	50.34	Semper Fidelis	37.3
Parsons' Fillbasket	171.3	Norwich Wonder	92.5	Pyne's Royal	47.48	Reader's Perfection	36.4
Northumberland	..	Reader's Perfection	85.7	Herbert	46.02	Baumforth B.	32.0
Fillbasket	169.1	..	..	Devon	41.9	Parsons' Fillbasket	32.3
Norwich Wonder	164.8	Devon	83.9	Parsons' Fillbasket	41.51	Herbert	31.6
Baumforth E.	152.2	Maclaren's Prolific	82.6	Reader's Perfection	36.06	Hornet D.	31.4
Maclaren's Prolific	144.6	Hornet D.	81.0	Maclaren's Prolific	34.3	Devon	19.4
Baumforth B.	139.6	Baumforth E.	77.2	Hornet D.	33.94	Goliath	..
Devon	122.6	Parsons' Fillbasket	77.0	Baumforth E.	30.26	Northumberland	..
Reader's Perfection	119.7	Baumforth B.	75.1	..	..	Fillbasket	Discarded
Hornet D.	118.0	Goliath	72.3	Baumforth B.	..	Baumforth E.	in
..	..	..	..	..	..	..	1929-30.

year. The yield per cane, however, has been falling steadily year by year as reference to Table V will clearly show. This falling off in yield per fruiting cane is so marked and has such a profound effect upon total crop yield that it would be a profitable starting point for a separate study. At the present juncture it cannot be discussed further, but the question naturally arises as to whether it is possible by any means to maintain the yield per fruiting cane at the high level attained in the first and second cropping years.

It is realised that the severity of cane thinning and tipping is an important consideration in raspberry culture. In this trial little or no attempt has been made to elucidate specific information upon this matter. It is clearly realised that this matter should be more thoroughly investigated, but it is pointed out that such an investigation requires special material planted and treated for this particular purpose. The present objective is the trial of varieties under some common form of cultural treatment.

TABLE V.

Showing the Average Crop per Fruiting Cane for the Four Years—1927-30.
Weight in Grams.

	1927.	1928.	1929.	1930.	Total.
Improved Beehive	312.7	127.1	83.8	66.1	589.7
Red Cross	291.2	116.6	65.1	89.3	562.2
Pyne's Royal	252.7	151.9	47.5	75.6	527.7
Lloyd George	238.0	114.0	50.3	82.2	484.3
Baumforth A.	243.6	121.0	74.6	44.3	483.5
Hornet A.	184.9	122.3	61.2	69.4	437.8
Duke of Cornwall	202.2	105.6	71.2	55.9	434.9
Herbert	240.0	109.3	46.0	31.6	426.9
Semper Fidelis D.	197.7	97.8	57.2	37.3	390.0
Norwich Wonder	164.8	92.5	53.1	44.5	354.9
Parsons' Fillbasket	171.3	77.0	41.5	32.0	321.8
Maclaren's Prolific	144.6	82.6	34.3	44.8	306.3
Baumforth B.	139.6	75.1	25.7	33.3	273.7
Devon	122.6	83.9	41.9	19.4	267.8
Hornet D.	118.0	81.0	33.9	31.4	264.3
Reader's Perfection	119.7	85.7	36.1	36.4	177.9
Goliath	294.6	72.3	51.94	Dis- carded in 1929-30	418.8*
Northumberland					
Fillbasket	169.1	113.2	63.51		345.8*
Baumforth E.	152.2	77.2	30.26		259.7*

* Total for the three years 1927-29.

TABLE VI.

Showing the positions of the Varieties in Order of Merit when classed under the heads of (a) Total and (b) Crop per Fruiting Cane.

	Varieties in order of merit as determined by <i>total crop</i> over a four year period.	Varieties in order of merit as determined by amount of crop produced per fruiting cane over a four year period.
1	Improved Beehive.	Improved Beehive.
2	Lloyd George.	Red Cross.
3	Baumforth A.	Pyne's Royal.
4	Herbert.	Lloyd George.
5	Parsons' Fillbasket.	Baumforth A.
6	Hornet A.	Hornet A.
7	Red Cross.	Duke of Cornwall.
8	Duke of Cornwall.	Herbert.
9	Maclaren's Prolific.	Semper Fidelis D.
10	Norwich Wonder.	Norwich Wonder.
11	Semper Fidelis D.	Parsons' Fillbasket.
12	Reader's Perfection.	Maclaren's Prolific.
13	Hornet D.	Baumforth B.
14	Baumforth B.	Devon.
15	Pyne's Royal.	Hornet D.
16	Devon.	Reader's Perfection.

In Table VI the order of the varieties as shown in Table III—which gives the total crop produced in four years—is given alongside the order of the same varieties when they are placed according to yield per fruiting cane.

It is interesting to notice from Table VI that, with the exception of Pyne's Royal and Red Cross, the order of varieties is very much the same in the two groupings. Pyne's Royal and Red Cross are outstanding in that they show very high yields per fruiting cane. Their case will be discussed again later.

(c) *Disease Susceptibility and Resistance.* In Table VII is set forth the number of canes that have been removed from the units on account of mosaic disease. The available records prior to 1930 give the number of infected stools that were removed. In Table VII these data have been translated into number of canes on the basis of 3 canes per stool in 1926, and 7 canes per stool in 1927 to 1929 inclusive.

The method adopted when removing cane for mosaic disease has been as follows. Obvious cases of mosaic disease in a stool have been treated by removing the stool completely. In cases where the leaves showed only traces of mosaic the canes were left in. By this method all that can be claimed for these stocks of raspberries is that they are commercially clean. The performance record of

the better yielding varieties is offered as evidence of the commercial freedom from disease. In other words this system of roguing has given a satisfactory commercial control since in the case of Red Cross and Duke of Cornwall, which have suffered the worst from mosaic disease, they have nevertheless given an average yield over a four year period of 1.9 and 1.8 tons per acre respectively. The raising of mosaic free stocks of raspberries is obviously the next step in the refinement of variety trials such as these at present under discussion.

TABLE VII.

Showing the Number of Canes removed from the units due to Mosaic Disease Infection. 1926-29 Numbers are estimated from the variety number of stools removed. Estimation based upon 3 Canes per stool in 1926 and 7 Canes per stool in subsequent years to 1929.

Variety.	1926.	1927.	1928.	1929.	1930.	Total.
Red Cross	39	133	63	189	8	432
Duke of Cornwall ..	45	56	56	35	99	291
Devon	54	28	—	42	—	124
Norwich Wonder ..	6	—	56	14	38	116*
Hornet A.	6	—	42	14	47	109
Pyne's Royal	12	—	35	21	8	76
Baumforth A.	—	—	—	7	—	7
Reader's Perfection ..	—	—	—	7	—	7
Lloyd George	3	—	—	—	—	3
Semper Fidelis D. ..	—	—	—	—	2	2
Baumforth B.	—	—	—	—	—	—
Hornet D.	—	—	—	—	—	—
Herbert	—	—	—	—	—	—
Improved Beehive ..	—	—	—	—	—	—
Maclaren's Prolific ..	—	—	—	—	—	—
Parsons' Fillbasket ..	—	—	—	—	—	—
<i>Varieties Discarded from Trials in 1929.</i>						
Goliath	—	—	98	—	—	98*
Northumberland Fillbasket	—	—	14	42	—	56
Baumforth E.	6	—	—	—	—	6

*These varieties suffer from a general diffuse kind of leaf mottling. See text later.

Reference to Table VII shows that the variety Red Cross has suffered very much from mosaic. As noted above, in spite of this, the variety has given an average yield of 1.9 tons per acre over a four year period. It is suggested that with clean stocks this performance might be considerably improved. The varieties Duke of Cornwall, Devon, Norwich Wonder, Hornet A and Pyne's Royal have all suffered more or less from mosaic. The order given is

that of descending intensity of the attack. Of the rest of the varieties Baumforth A, Reader's Perfection, Lloyd George and Semper Fidelis D. have had less than 10 canes removed in 4 years. The remaining varieties under discussion have not had any canes removed for mosaic disease.

It should be noted, that in the case of Lloyd George, although the original units have not suffered from mosaic disease, yet in another planting of this variety upon this plot where the equivalent 21 units are planted, there has been a serious amount of cane removed because of mosaic infection. This is difficult to account for since the stock for this later planting was obtained from the same stools as that for the earlier one. Clearly the question of mosaic infection is an important consideration in raspberry cultivation.

In the case of Goliath and Norwich Wonder, these varieties suffer severely from a mild form of mosaic which seems to infect the whole stock. At least this condition applies throughout the stocks of these varieties at Long Ashton. The infection is so general that if the roguing in these varieties had been on the same basis as in the other varieties the whole stock would have been eliminated. This is rather surprising since Goliath cropped 2 tons per acre over the three year period it was included in these trials. Norwich Wonder has also given an average crop of $1\frac{3}{4}$ tons per acre over the four year period. Here again the question is raised as to how far mosaic disease can and does affect the yields of raspberries under commercial conditions.

The variety Pyne's Royal although standing next to Devon at the bottom of the list in total crop has not suffered so heavily from mosaic as some of the other varieties. In 1930 this variety was the fourth highest yielder. There is a suggestion that the variety is slow to establish itself, and that it needs good cultural treatment. In view of the high quality of the berry it is a variety which, if it can be grown successfully, would no doubt well repay cultivation.

It is probably significant that the highest yielding varieties, namely Improved Beehive, Lloyd George and Baumforth A have in these trials been free from mosaic. It should not be inferred from this that the varieties are immune. The case of Lloyd George mentioned above is evidence that this variety at least may suffer. The varieties, however, are all growing together on one plot, and no special precautions are taken to prevent infection. It will be interesting to note how long these varieties remain free from mosaic under the conditions of this trial.

The two varieties, Reader's Perfection and Baumforth B, have both suffered considerably from anthracnose. Since no precautionary measures are used against anthracnose and the disease has only appeared on these varieties, and has done so on the various units of these varieties over the entire plot, there is a strong suggestion that it is a varietal susceptibility. Neither of these two varieties, however, have suffered from mosaic.

Baumforth E and Northumberland Fillbasket have both suffered badly from mildew. Here again there is a strong suggestion that this is a varietal susceptibility, and that it might prove a very serious handicap to these varieties under ordinary cultural conditions.

The variety Devon suffers from a form of chlorosis which makes the variety most conspicuous. Early in the season the leaves turn a pale lemon yellow and do not recover. This serious defect is no doubt responsible for reducing the yield, so that the variety stands at the bottom of the list in total crop yield, and makes it an unprofitable variety for Long Ashton conditions.

It is realised, of course, that these notes upon disease susceptibility are somewhat unsatisfactory from the finer analytical standpoint. Notwithstanding this, however, they are offered as embodying an experience of these varieties over a five year trial period, and in some cases a longer observation period. From the experimental view point this work is clearly a trial of varieties under more or less commercial conditions and the results are offered as such in the hope that they may be of benefit to growers; as opportunity affords the work will be refined in its technique, and the results accordingly increased in value and application.

GENERAL DISCUSSION AND VARIETAL CHARACTERISTICS.

(a) *Nomenclature.* The varieties given with a suffix letter such as Baumforth A and Baumforth B are as identified and distinguished by Grubb (2).

The names of most varieties will be known to most readers, but the following brief notes may be of value :—

HERBERT. A variety found as a chance seedling in 1887 in the garden of Mr. R. B. Whyte, of Ottawa, Canada.

IMPROVED BEEHIVE. A variety from the Tamar Valley District. Introduced by Messrs. Snell.

DUKE OF CORNWALL. A variety from the Tamar Valley. Introduced by Messrs. Snell.

PARSONS' FILLBASKET. An otherwise unnamed variety obtained here as Fillbasket.

(b) *Varieties of Doubtful Commercial Value.* It was noted earlier that the varieties Goliath, Northumberland Fillbasket and Baumforth E were eliminated from the trials in 1929-30 for the reasons given. The following varieties are also of doubtful commercial value for the appended reasons :—

BAUMFORTH B. In the present trial this variety has not cropped well, although some years ago it did grow and crop well under the shade of plum trees at Long Ashton. The fruit is essentially of dessert quality but of a very dry nature, tending to break apart easily during picking. The colour of the fruit is poor.

MACLAREN'S PROLIFIC. This variety is one of the medium croppers and at first promised well. During the early part of the season the berries plug moderately easily, but as the season advances the later berries are more and more difficult to plug, and the last fruits are extremely difficult to remove from the plug. In any case the variety must be picked with great care in order to obtain a satisfactory sample. The fruit is rather sharp and is essentially of a culinary nature.

HORNET D. The fruit is of poor quality and breaks easily when picked. It is also a poor yielder, and the variety has now been eliminated from the trials.

SEMPER FIDELIS D. This variety is a medium cropper, but the fruit is extremely soft and difficult to plug, and is rather sharp. The plugging difficulty in this variety is very pronounced, so that even under favourable picking conditions the fruit sample is often very poor indeed.

PARSONS' FILLBASKET. The fruits are small and very soft in texture. The variety ranks with Devon for lateness and may have some commercial value on this account. It is essentially a culinary berry.

DEVON. This variety has given very poor yields in these trials. The leaves suffer very much from a yellowing very early in the season. The berries are very dry and the drupelets easily break apart. These characters have produced unsatisfactory results in the trials.

(c) *Varieties of Possible Commercial Value.* This preliminary elimination leaves nine of the varieties for further consideration, viz. :—

IMPROVED BEEHIVE has shown itself to be the heaviest cropper over the four year period. It has also an additional factor in its favour, that of earliness. The variety is healthy and of medium vigour. The fruit is rather small, round, of a bright but not deep colour, firm, easy to plug and rather sharp. It is a very promising variety because of its high cropping powers and earliness.

LLOYD GEORGE. This variety is too well known to need description. It has maintained its reputation in these trials as seen in Table VI, being second on the list in total crop.

BAUMFORTH A. This variety is essentially a jamming raspberry. The fruit is very sharp, round, and although tending to be a little soft, picks well under favourable conditions, but tends to be very squashy under wet conditions. The berry is of good size. The cane is plentiful, rigid and vigorous. The variety occupies the third place in the list of total crop given in Table VI.

HERBERT. This variety takes the fourth place in the list of total crop performance. The variety is fairly vigorous and has a large root spread. The fruit is large, round, of bright but not deep colour, fairly firm but rather sharp for dessert purposes. It ripens about mid-season. It is a favourite variety in Canada.

- HORNET A.** This is an early variety. The canes are rigid and will stand without support. The fruit is large and conical, with a deep though rather dull colour. It is a sweet berry of fairly firm texture. It is, however, rather subject to mosaic, but in spite of this its size and earliness probably make it worth considering as an early dessert berry on a small scale. It is about a week later than Norwich Wonder.
- RED CROSS.** The fruit is large and conical, and of deep dull colour, but sharp for most dessert tastes. It is very subject to mosaic, and were it not for mosaic disease the variety would no doubt have been further up in the list of total crop. It is a promising variety otherwise.
- DUKE OF CORNWALL.** This variety is also rather subject to mosaic, and the total crop has undoubtedly suffered from the grubbing of stools on this account. It produces a fine large round berry, rather dull in colour, but both sweet and firm. It is a mid-season variety and is well worth consideration for punnet sales.
- NORWICH WONDER.** This variety produces rather short canes, which will often stand without support. It produces large round berries and is very early. The fruit is sweet and fairly firm. On account of earliness and good dessert quality it is a variety worth consideration where it is desired to grow good fruits for early market. It appears to be very subject to mosaic disease, but this has not affected the yield too adversely.
- PYNE'S ROYAL.** This variety has undoubted dessert qualities. Under the conditions of this trial the canes have been very short and have stood without support. The fruits are very large tending to be conical in shape and are sweet and fairly firm. The variety, however, seems very subject to mosaic.

GENERAL CONCLUSIONS.

It is clearly unwise categorically to recommend some varieties for general commercial culture and to discourage others merely on the results of these trials since soil, climatic and other factors may play such important parts in determining varietal suitability to localities.

Trials such as these, however, do serve to clear broad issues, and the following generalisations are tentatively offered.

The varieties Improved Beehive, Lloyd George and Baumforth A have given high yields consistently over the four year period. They are also varieties which are relatively free from disease. The variety Lloyd George needs no comment at this point since it has, in these trials, justified the extended planting that has taken place in recent years. That two other varieties should be in the same class with Lloyd George in the matter of crop yield is suggestive from the growers view point. It is important, and probably significant, that these two varieties—Improved Beehive and Baumforth A—have not suffered from mosaic. Reference to Table VII will show that no canes have been removed on account of disease. The stock used for this trial is undoubtedly healthy, and there is every indication that the varieties are fairly resistant to mosaic diseases. Time alone will decide this issue. Of these two varieties Baumforth A is pre-eminently a berry to grow for

bulk production for jam-making. For punnet sales the fruit is rather soft and a little tart. Improved Beehive gives a much firmer and sweeter berry than Baumforth A, but the size is rather small. It is moreover in the early class. It is a variety which might well be tried on a small scale by growers prior to extended planting. The cane is not so vigorous as that of Baumforth A, but it is by no means a weak grower.

Of the remaining varieties Herbert is promising, having given an average yield of 2 tons per acre over a four year period. It is also a variety that has not suffered from disease, and is a good strong grower.

The varieties Red Cross and Duke of Cornwall have given an average yield of 1.9 and 1.8 tons per acre respectively. They have, however, both suffered badly from mosaic. They are both varieties of merit. Duke of Cornwall is a very desirable punnet berry, being firm and of good appearance although rather dull. The berry of Red Cross is of a deep red colour and attractive. Both varieties are worthy of trial, particularly if care is given to eliminate mosaic disease from the stock. How far this can be achieved it is not yet possible to foretell.

Norwich Wonder is a very early dessert berry, but has suffered from mosaic. In the trials the yield has been $1\frac{3}{4}$ tons per acre per annum over the year period. The main feature of this berry is its earliness.

The case of Pyne's Royal has already been discussed. It is a most desirable fruit for punnet sales. It does, however, appear to require special conditions to form canes of satisfactory length

Of the remaining varieties none appear to merit special mention. Their cases are discussed earlier, and there appears no need of further treatment at this point.

It is stressed again that the results reported in this paper have been obtained at Long Ashton, where the rainfall is relatively high. It is also pointed out that the report of the raspberry trials at the East Malling Research Station is being published in Annual Report of that Station for 1930. Growers are strongly advised to study the two reports conjointly.

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THE INFLUENCE OF THE POSITION OF THE TOP BUD OF THE SCION UPON THE STAND OF GRAFTS.

BY THOMAS SWARBRICK.

INTRODUCTION.

Budding and grafting methods make up a considerable part of the nurseryman's technique. It is at present necessary in practice to perpetuate certain species by some form of grafting, and this raises many problems concerning the symbiotic growth of rootstock and scion.

From the view point of the scientific investigator the processes involved in the uniting of the tissues of the stock and scion are important and are at present under intensive study by several workers. On the other hand there are problems for the purely practical budder and grafter, such as the following. Should some varieties of apple, plum and pear be budded or grafted early or late? Do all stocks of a species "take" buds or grafts at the same time with the same success? Are there any small points of procedure which will increase the "take" of grafts or buds, or increase the growth uniformity of the scions?

The investigation described in this paper is largely directed towards an answer to this last question. It is common knowledge amongst propagators that budding gives on the whole a more uniform lot of trees than does grafting, where the same rootstock is used throughout. The reason for this uniformity when budding is practised, if better understood, may give a clue to the more variable results produced by grafting. It seems probable that a more uniform start in spring is part of the explanation.

When preparing a graft in the whip and tongue method the top bud of the scion may bear one of four position relationships to the tongues of the stock and scion, the cambiums of which are made to match when the graft is set. It is only on rare occasions that the stock and scion are the same size, so that there is often a completely mismatched side on the whip and tongue graft. The top bud of

the scion, therefore, may be in any one of the four following positions :—

- (1) Directly in line with the matched cambiums in the tongues of scion and stock.
- (2) Directly above the lip of the scion.
- (3) Directly above the lip of the stock.
- (4) Directly over the mismatched tongues of the scion and stock, *i.e.*, on the opposite side to position number one.

The question of the best position for the top bud of the scion has been the subject of considerable investigation by Roberts in America (1). He concludes that the best position is undoubtedly that given first above, namely, when the top bud of the scion is directly in line with the matched cambiums in the tongues. He affirms from his studies that with the top buds in this position there is a better stand of grafts, and furthermore that it is a more uniform stand as regards tree size. Other investigators have apparently not been able to get such clear cut results as those Roberts gives.

Since the question of tree uniformity is so much in evidence at the present time, this problem of the best bud position in grafting is clearly one which should be investigated under our own climatic conditions, and the present investigation therefore has been begun. While the preliminary results are presented at this time the subject forms part of the larger general investigation of rootstock and scion inter-relationships which is proceeding at Long Ashton.

EXPERIMENTAL METHODS AND MATERIAL.

In spring 1929 about two thousand miscellaneous French seedling apples of two years old were imported. These were sorted over and approximately eight hundred of the worst seedlings were taken out. These were planted in the nursery row in the manner ordinarily adopted where the production of standard trees is intended. The nursery site was a rather poor location, with soil showing a strong tendency to induce leaf scorch in the trees planted thereon.

In spring 1930 these miscellaneous seedlings were grafted with two scion varieties—Bramley's Seedling and White Alphonso. The latter is a West Country cider variety. Two varieties only were used in order to keep the issue as clear as possible. When making the grafts the cuts were made so that the top buds occupied one of two positions : (*a*) in line with matched tongues of the stock and scion (Position 1 in the above list), and (*b*) in line with the mismatched tongues of the stock and scion (Position 4 in the above list). The grafts were all made by the same operators so that as far

as possible the cutting, etc., should be the same throughout. Weekly growth measurements were made of all these trees, and they will be kept under observation until they leave the nursery in three years time. These two bud positions were chosen because, according to Roberts, they are the best and worst respectively.

RESULTS.

The results obtained in this preliminary study are given in the broadest possible manner since it is realised that much more extended workings will be necessary before a final and complete conclusion can be given.

Table I sets forth in 10 cms. classes, and with special reference to the top bud of the scion, the distribution of the trees of the two varieties.

For convenience of reference the maiden trees have been collected into classes, each class with a ten centimetre (approx. 4 inches) range. This enables it to be seen at a glance which class contains the largest number of trees, and also the way in which the trees are scattered round this main group.

It will be seen from Table I that the variety White Alphington is the more vigorous variety, since it has grown larger than Bramley's Seedling. Neglecting for a moment the bud positions, it is shown that over 75% of the White Alphington trees are 100 cms. long or over, whereas not more than 20% of the Bramley trees are of this size. This difference in size is brought out very clearly in Table I.

Considering now the effect of the bud position upon the grouping of the trees into classes, it is clear that the bud in line has given the better results. In the case of White Alphington the largest group of trees of this type is in the 110-120 cm. class, whereas where the top buds were over the mismatched tongues the largest group was in the 100-110 cm. class, *i.e.*, 10 cms. less. In the case of Bramley's Seedling there is no difference between the two positions of the largest groups: They occur in the 90-100 cms. class for both bud positions.

The second feature brought out by Table I is that where the top buds are over the mismatched tongues, there is an appreciably larger number of trees in the *small* size classes. This is true for both Bramley Seedling and White Alphington. Thus with the bud in line in White Alphington there are only 9% of the trees below 90 cms. in length, whereas in the other bud position there are 24% of the trees less than 90 cms. long. In Bramley's Seedling with buds in line there are 18% of the trees less than 80 cms. long,

whereas with the buds in the other position there are 23% of the trees less than 80 cms. long.

It appears therefore that both as regards the size and uniformity of the trees the bud-in-line is the better of the two positions. It gives more large trees and fewer small trees.

The effect of the bud position upon the take of grafts is shown in Table II. In the case of White Alphington there is no difference, but in the case of Bramley's Seedling there is a difference of 9% in favour of the bud-in-line position.

Considering statistically the data upon tree size, it is found that there is a significant difference in favour of the bud-in-line in both cases. The data are set out in Table III where it is found that the average height of the White Alphington bud-in-line trees is 4.8 cms. greater than the average height of bud-on-side trees. The probable error of this difference is ± 1.32 cms. so that the difference in favour of the bud-in-line can be regarded as significant. The case of Bramley Seedling is more conclusive still. In this case the difference is 21.4 cms. in favour of the bud-in-line trees, with a probable error of this difference of ± 1.42 cms. It is clear, therefore, that in the matter of uniformity and tree size the advantages always in favour of the bud-in-line position.

DISCUSSION.

It is fully realised that these results are not obtained with very large numbers of trees and are therefore not fully conclusive. It must be pointed out, however, that they are obtained from trees where miscellaneous seedlings served as the rootstocks. In view of this fact the general uniformity of the whole set of trees is most interesting.

It is clear, from these preliminary observations that the advantages are always in favour of the bud-in-line position. In the case of White Alphington there are less small trees, 9% as against 24%, and there are more large trees 75% as against 60%. The stand of grafts was not affected in this variety by the position of the top bud of the scion. With Bramley's Seedling the stand of grafts was much better in the case of bud-in-line grafts, 84% as against 75%. The effect upon tree uniformity has been quite noticeable, but not so marked as in the case of White Alphington.

In conclusion, therefore, it would appear that under ordinary conditions it will be advantageous to make grafts with the top bud in line with the matched cambiums of the tongues of the stock and scion.

In practice this is not so difficult to accomplish as might at first be imagined. When grasping the scion preparatory to cutting the sloping edge of the graft, it is only necessary to place the scion in the ball of the hand so that the bud can be seen by the operator when he is making the "slope" cut. By a little observation and practice each worker will soon find the correct bud position, since it will depend slightly upon the angle of cutting. Each worker has his own peculiarity in this respect, but with a little practice it is comparatively easy to make the grafts so that the top buds come almost, if not directly, in line with the matched cambium of the tongues of the stock and scion. In spring 1930 the method was shown to an experienced grafter, and within a few hours he found it quite easy to make the scions with the top bud in such a position that when the graft was completed the top bud was in line with the callus unions.

Acknowledgment is due to Mr. Umpleby for the collection of the measurements throughout the season.

REFERENCE.

- (1) ROBERTS, R. H. "Factors affecting the Variable Growth of Apple Grafts in the Nursery Row." *Wisconsin Ag. Exp. Stat. Res. Bul.* 77, 1927.

TABLE I.

Showing the effect of top bud position of the scion upon the growth of the grafts. Scions set on to miscellaneous seedling rootstocks. Results expressed upon a percentage basis. Trees collected into 10 cm. classes. Measurements in cms.

	Less than 70 cms.	70-80 cms.	80-90 cms.	90-100 cms.	100-110 cms.	110-120 cms.	120-130 cms.	130 cms.
<i>White Alphington.</i>								
Bud in line ..	1.6	3.3	4.1	17.9	23.6	29.3	15.4	4.9
Bud on side ..	4.1	5.7	14.0	16.1	23.8	18.9	15.7	1.6
<i>Bramley's Seedling.</i>								
Bud in line ..	8.0	9.6	26.4	37.6	17.6	0.9	—	—
Bud on side ..	11.3	12.0	25.3	36.6	13.3	1.3	—	—

TABLE II.

Showing the total number of grafts made and the failures. Grafts made with top bud of scion in two opposite positions.

	Total Number of Grafts.	Number of Failures.	Percentage Failures.	Percentage Stand of Grafts.
<i>White Alphington.</i>				
Bud in line ..	153	34	22	78
Bud on side ..	157	36	23	76
<i>Bramley's Seedling.</i>				
Bud in line ..	150	22	18	84
Bud on side ..	205	52	25	75

TABLE III.

Showing the standard deviation and probable errors of the trees of Bramley Seedling and White Alphington when worked in two bud positions.

Variety and Treatment.	Total No. of Trees.	Average Height per Tree.	Standard Deviation.	P.E.
<i>White Alphington.</i>				
		cms.		
Bud in line	115	109.5	13.6	$\pm$ 0.851
Bud on side	119	104.7	17.4	$\pm$ 1.072
Difference	—	4.8	—	$\pm$ 1.32
<i>Bramley Seedling.</i>				
Bud in line	128	90.9	11.1	$\pm$ 0.658
Bud on side	150	69.5	23.2	$\pm$ 1.260
Difference	—	21.4	—	$\pm$ 1.42

SOME EFFECTS OF BARK RINGING ON THE COMPOSITION OF FRUIT TREES.

BY T. WALLACE, V. L. S. CHARLEY AND J. O. JONES.

The practice of bark ringing the main stem or the larger branches of fruit trees has been utilised for many years as a means of bringing into bearing vigorous, unfruitful trees. The method initially adopted was to remove a complete ring of bark from the trunk or branch during May and to cover the wound by some means to prevent the cut tissues from drying out in order that the exposed surfaces might callus quickly and the wound heal over.

During the past few seasons ringing has become extremely popular in the fruit areas of this country, but the method of two half rings on opposite sides of the selected limb, at a few inches apart, has generally been employed instead of the older method of the complete ring. The half ring method has yielded results similar in character to those obtained by the method of complete ringing but has proved a safer method for use on a commercial scale.

There is no doubt that the extensive ringing which has been done has converted many previously barren trees into fruitful ones, but, in addition to this, it has drastically changed the character of the fruits in many cases.(2) The effect of ringing on the quality of the fruit has not always been consistent in every detail. Thus in certain cases the effects have been scarcely noticeable while in others they have been extremely well marked. Fruit size has sometimes been increased and in other cases the reverse effect has resulted. Colour has usually been greatly intensified and firmness much increased. These two latter effects have frequently added considerable value to the fruit where dessert varieties of apples are concerned, and have thus contributed in no small measure to the popularising of the practice.

In view of the present importance of ringing, the writers have carried out several experiments during the past three seasons with a view to determining the special storage characters of fruits from ringed trees and, in connection with the experiments, chemical investigations on the fruits and on the shoot portions of ringed trees have been carried out.

In the present paper the results obtained in a chemical investigation on leaves and bark and wood portions of current season's shoots and on fruits from a batch of apple trees, variety Bramley's Seedling, some of which had been ringed, are given.

The ringing of the main stem or of a large branch of a vigorous apple tree in May is usually followed by the development of characteristic effects on shoot growth and foliage characters during the season of the ringing operation, but, if the ring heals over effectively during that season, the shoot and leaf characters may appear practically normal during the following season. The symptoms usually shown are decreased shoot growth, decreased amount of foliage and smaller leaves, which are generally of pale yellow-green colour, may show scorching of the margins and may develop reddish or purplish tints in the autumn.

The effects suggest a condition of relatively low nitrogen within the trees and this is further suggested by the appearance of the fruits which, as stated above, are often highly coloured and very firm, thus resembling fruits which result when trees are subjected to low nitrogen conditions of nutrition.

As the result of ringing experiments carried out on the woody shoots of peach, privet and lilac, Curtis (1) has suggested that the treatment hinders the movement of nitrogen and ash constituents into the tissues above the ring and has advanced the idea that this may be due to the fact that the nutrients concerned may be carried upwards chiefly in the phloem. He points out, however, that the operation may lead to changes in the xylem tissues, leading to the plugging of the xylem vessels. Whichever explanation may be shown subsequently to be correct, there is no doubt that the data presented by Curtis in his experiments show that the leaf and stem portions above the rings received smaller supplies of nitrogen and ash constituents than did comparable tissues not subjected to ringing treatment.

The present experiments differ from those of Curtis in that not all the tissues above the rings were examined, while Curtis selected paired twigs or branches on single plants below which were other branches bearing leaves which could supply the root systems with elaborated foods. In our experiments the main trunks were ringed, the material examined consisted only of current season's shoots and fruits, and the comparisons were between materials from different trees, ringed and unringed, and as nearly comparable as it is possible to obtain in a fruit plantation.

Experimental.

The trees used in the experiment were half standard apple trees,

variety Bramley's Seedling on Malling B. rootstock, growing in one of the Research Station plots. They were planted in the fall of 1919 at 15ft. square, and from planting up to the time of the experiment, had been grown under ideal conditions for vigorous vegetative growth.

The growth features of the trees were very similar, and as none of them showed any signs of coming into bearing in 1927 a few were ringed, using a complete ring around the main trunk. The treatment caused these trees to bear their first crop in 1928 and, in view of this, it was decided to ring a proportion of the trees in each subsequent year. Further batches of trees were ringed in May 1928 and 1929 and the trees treated in these years were utilised in the experiment.

In both years complete rings were made round the main stems by means of a sharp knife and immediately on ringing the exposed tissues were covered with surgical tape to prevent drying. In the case of one tree, the wound was not covered immediately and, as a result of this, in July, the wound had not commenced to heal over, and the tree was in a very weak condition. In every other case the wounds healed quickly, and although the treatments produced the typical symptoms during the season of the ringing operation, *i.e.*, much reduced shoot growth and pale foliage, greatly reduced in size, in the season following, both foliage colour and fruit characters were almost indistinguishable from the features exhibited by the untreated trees.

The shoot samples, details of which are given below, were collected on July 9th, 1929, while the samples of fruits were gathered on October 10th.

Notes made on July 9th relating to Shoot Samples.

Unringed. The growth of the trees was very vigorous; foliage was luxuriant, leaves large and deep green in colour; the terminal shoots were still elongating and the tips of the shoots were soft to a distance of 1in. to 1½in. from tips; the crops were very small.

Ringed 1928. The rings were completely healed over, the growth characters were similar to the unringed, leaves being deep green and large, shoots still growing and with tips soft to a distance of 1in. to 1½in.; crop was medium, being much heavier than the unringed or ringed 1929, but shoots were only taken where fruits were sparse or absent.

Ringed 1929. Shoot growth was much reduced and the tips of the shoots were practically rigid to the tips; shoot elongation had apparently ceased and terminal buds were forming; leaves were pale and relatively small; crop was similar to unringed.

Ringed 1929. *Unhealed*. The condition of this single tree was similar to those of ringed 1929 series, excepting that it looked in poorer condition and the shoots were not firm.

In taking the shoot samples, specimens typical of the terminal growths were collected in each case, care being taken to avoid those which had not started at the beginning of the season, and efforts being made to select shoots from comparable portions of the trees in each case. The whole current season's growth was taken in the case of every shoot.

The notable points about the samples were the much larger shoots and more luxuriant foliage from the unringed and ringed 1928 trees than from the trees ringed 1929.

The shoots were all collected under favourable weather conditions within a period of 30 minutes. Immediately on gathering they were transported to the laboratory in grease proof paper where each shoot was divided in three portions for analysis, viz., laminae of leaves, bark plus petioles, and wood. The preparation of the material occupied the course of an afternoon, and during this stage of the work efforts were made to keep conditions as comparable as possible for all samples.

The fruits used in the work were typical of the crops borne in each case, but since the crops carried on the unringed and ringed 1929 trees were extremely light, no elaborate sampling method could be employed. In selecting the actual fruits for analysis, fruits of comparable sizes were chosen and abnormally large or small specimens were avoided. Comparable portions of the fruits were used for each analytical determination, only the pulp of the peeled and cored fruits being used. It should be pointed out that the dry weights on the fruit samples were determined by drying the pulp in a steam oven at 70°C. for a period of 7 days, during which period they attained constant weight.

In selecting and preparing the fruits for analysis, it was noted that those from the unringed and ringed 1928 trees were similar in appearance and character of the flesh, the skins being green and the flesh relatively soft and juicy to cut, while those from the 1929 ringed trees had red skins and the flesh was much whiter, harder and less juicy than those from the unringed trees.

No fruits were obtained from the 1929 unhealed tree owing to lack of crop at harvesting time.

Results.

The chemical data obtained on the shoot portions and on the fruits are assembled in Tables I to IV.

TABLE I.

Showing the Contents of Dry Matter, Nitrogen and Total Ash in Fresh Weight in the Shoot Samples from the Unringed and Ringed Trees.

Treatment.	Material Analysed.	Dry Matter. %	Total Nitrogen. %	Total Ash. %
Unringed.	Leaves ..	35.64	0.894	2.171
	Bark ..	32.35	0.361	2.168
	Wood ..	36.42	0.337	0.874
Ringed 1928.	Leaves ..	36.78	0.870	2.171
	Bark ..	34.22	0.351	2.292
	Wood ..	38.90	0.318	0.895
Ringed 1929.	Leaves ..	40.65	0.562	1.664
	Bark ..	39.74	0.282	1.628
	Wood ..	45.07	0.230	1.037
Ringed 1929. Unhealed.	Leaves ..	40.95	0.504	0.859
	Bark ..	36.22	0.251	1.738
	Wood ..	41.72	—	0.709

In Table I the values for dry matter, nitrogen and ash as percentages of fresh weight in the shoot portions are given.

The data for the Unringed and Ringed 1928 samples show a close similarity for the respective materials concerned, whereas those for the 1929 ringing treatments show sharp differences from these materials and have points in common with each other. It would appear that any effects produced by the 1928 ringing had been practically overcome by 1929, a view which is also supported by observations on the trees themselves and by the data presented in Tables II and IV, the latter relating to the fruits.

The further points which require mention are as follows: the ringing treatments resulted in high percentage dry matter and low total nitrogen in all cases, and in low ash contents in the 1929 samples except in the wood portion of the Ringed 1929 sample.

The results reported in Table II relate to ash content in dry matter and to ash constituents. They show that the 1928 ringing

TABLE II.
Showing Data relating to Ash and Ash Constituents.

Treatment.	Material Analysed	Ash in Dry Matter %	Ash Constituents.									
			As % Ash.					As % Dry Matter.				
			CaO	MgO	K ₂ O	Na ₂ O	P ₂ O ₅	CaO	MgO	K ₂ O	Na ₂ O	P ₂ O ₅
Unringed.	Leaves Bark Wood	6.1	24.2	6.6	29.4	3.2	7.1	1.4	0.40	1.8	0.19	0.43
		6.7	30.9	5.1	24.5	3.0	4.4	2.1	0.34	1.6	0.20	0.29
		2.4	22.1	4.7	21.2	2.8	8.8	0.54	0.11	0.52	0.06	0.21
Ringed 1928.	Leaves Bark Wood	5.9	20.6	6.4	31.8	3.1	7.1	1.2	0.37	1.8	0.18	0.42
		6.7	28.4	5.8	25.8	2.8	4.3	1.9	0.38	1.7	0.18	0.29
		2.3	24.3	7.3	23.9	2.6	9.4	0.56	0.16	0.55	0.06	0.20
Ringed 1929.	Leaves Bark Wood	4.1	13.6	5.9	38.3	2.6	7.4	0.56	0.24	1.5	0.10	0.30
		4.1	30.1	5.7	25.2	2.7	4.9	1.40	0.27	1.1	0.11	0.23
		2.3	17.3	5.1	24.7	2.3	8.6	0.40	0.11	0.57	0.05	0.19
Ringed 1929. Unhealed.	Leaves Bark Wood	2.1	13.4	5.1	39.9	2.5	7.8	0.29	0.12	0.87	0.05	0.17
		4.8	26.3	5.6	28.4	3.0	5.3	1.2	0.27	0.57	0.05	0.25
		1.7	20.0	4.4	25.8	2.9	11.5	0.34	0.27	0.44	0.05	0.19

TABLE III.

Showing various Constituents in Fresh Weights of Leaf, Bark and Wood Samples as Percentages of the respective Constituents in the Fresh Weights of the Unringed Samples.

Treatment.	Material.	Dry Matter. %	Total Nitrogen. %	Total Ash. %	Ash Constituents.				
					CaO %	MgO %	K ₂ O %	Na ₂ O %	P ₂ O ₅ %
Ringed 1928.	Leaves	101.5	87.5	100.0	87.0	93.9	101.5	91.8	99.1
	Bark	105.8	97.2	105.8	95.7	118.2	112.4	95.2	105.8
	Wood	106.8	94.4	102.3	118.7	155.3	113.0	106.8	101.7
Ringed 1929.	Leaves	112.1	56.5	75.4	44.8	67.3	93.4	59.0	78.2
	Bark	122.8	78.1	75.2	81.9	97.5	84.4	67.5	97.4
	Wood	123.8	68.3	118.7	91.7	123.8	135.7	103.1	112.0
Ringed 1929. Unhealed.	Leaves	113.0	51.9	38.9	23.4	33.9	54.6	30.4	44.7
	Bark	111.9	69.5	80.1	63.9	88.8	39.9	28.0	96.4
	Wood	114.6	—	81.2	72.2	91.8	97.0	95.5	103.7

TABLE IV.
DATA ON FRUIT PULP—1929 CHOP.

Treatment.	Dry Matter in fresh weight. %	Total Nitrogen in fresh weight. %	Reducing Sugars (as laevu- lose) in fresh weight. %	Sucrose in fresh weight. %	Total Sugars as Hexoses	Total Hexoses Nitrogen	Acidity (as Malic acid) in fresh weight. %	Ash in Dry Matter. %	Ash Constituents as % Ash.					Ash Constituents as % Fresh Weight.				
									CaO	MgO	K ₂ O	Na ₂ O	P ₂ O ₅	CaO	MgO	K ₂ O	Na ₂ O	P ₂ O ₅
Unringed	12.35	0.0481	6.72	1.88	8.70	180.8	1.10	1.7 (0.21)	2.4	2.5	54.8	4.7	8.7	0.0052	0.0054	0.119	0.010	0.018
Ringed 1928	12.05 (97.6)	0.0367 (76.3)	6.4	2.13	8.50	231.5	1.04	1.8 (0.22)	2.1	2.4	55.5	5.1	7.1	0.0046	0.0053	0.122	0.011	0.015
Ringed 1929	14.6 (118.2) *	0.0133 (40.1) *	6.51	2.96	9.63	497.7	1.12	1.5 (0.22) †	2.4	2.4	54.6	5.1	9.0	0.0055	0.0055	0.126	0.011	0.020

* Values in Brackets in these columns show amounts as percentages of the amounts present in the Unringed Sample.

† Values in Brackets in this column show amounts as percentages of Fresh Weights.

treatment did not materially affect the ash content or the proportions of the various ash constituents in ash or dry matter during 1929. As the result of the 1929 ringing treatments, ash content in dry matter was significantly lowered except in the wood of the Ringed 1929 sample, while the proportions of CaO and K₂O in the ash of the leaves were distinctly altered, CaO being lower and K₂O higher as a result of the ringing treatments.

The data recorded in Tables I and II are arranged in Table III in such a way as to show clearly the effects of the ringing treatments on the contents of the various constituents in fresh weight by comparison with the contents of the materials from the unringed trees.

In this table it is seen that dry matter has been significantly increased by the 1929 ringing treatments; total nitrogen has been lowered in all cases; ash content has been reduced in all 1929 ringing samples except in the wood of Ringed 1929; CaO has been decreased in the 1929 samples, especially in the Unhealed; other ash constituents also frequently show reduced percentages, though in certain cases, especially in the wood, the reductions are not significant or there may be definite increases—*e.g.* MgO and K₂O in wood of Ringed 1929. It is notable that there is usually an upward gradient in values in the direction leaves, bark, wood.

The salient points in the data relating to the fruits, which are presented in Table IV, are as follows:—

The effect of the 1929 ringing treatment was much greater than that of the 1928 treatment, much of the effect of the latter having apparently disappeared by 1929; high dry matter, accompanied by high sucrose and high total sugars, resulted from the 1929 treatment; both ringing treatments produced lowered nitrogen contents of the fruits; percentage acidity was not significantly altered; the ratio $\frac{\text{total sugars as hexoses}}{\text{nitrogen}}$ was enormously increased by the 1929 ringing and only slightly so by the 1928 treatment; neither the ash content nor the proportions of ash constituents in ash or fresh weight showed significant effects from the treatments.

The effects produced on the fruits by the 1929 ringing treatment have been observed by us in many other experiments of a similar character, but in some cases it has been found that, although total sugars have been significantly increased by ringing, the percentages of sucrose in the ringed samples have been lower than in the unringed ones, the increases being due to high proportions of reducing sugars.

SUMMARY AND CONCLUSIONS.

1. An account is given of chemical investigations carried out in connection with an experiment on the bark ringing of apple trees, variety Bramley's Seedling.

2. Of the trees used in the experiment, some were left unringed, some were bark ringed round the main stems in May 1928 and others in May 1929.

3. Samples of typical current season's shoots were taken from the trees in July 1929 and samples of fruits in October 1929. The shoot samples were divided into leaves, bark and wood portions for analysis, and in the case of the fruits determinations were carried out on the pulp.

4. When the samples were taken the effect of the 1928 treatment was scarcely visible either on shoot or fruit characters, but the 1929 ringing treatments were showing typical "ringing" effects.

6. The chief effects resulting from the ringing treatments, as revealed by the analytical results, are as follows:—

The residual effects from the 1928 treatment were negligible except in the case of total nitrogen content of the fruits.

The 1929 ringing treatments resulted in high dry matter, low total nitrogen and low total ash (except in wood in one case) in fresh weight in all portions of the shoots; ash constituents, especially CaO, were also generally low in these cases.

These treatments were also associated with relatively low proportions of CaO and high proportions of K₂O in the ash of the leaves.

In the fruits, dry matter, sucrose and total sugars were high and total nitrogen was low; acidity, total ash and proportions of ash constituents were not significantly affected.

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PRELIMINARY OBSERVATIONS ON THE NITROGENOUS MATERIALS IN APPLES DURING STORAGE.†

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The present paper is an attempt to throw further light on the problems presented by the breakdown of apples in storage. While considerable numbers of analyses of sugars and of acidity in stored apples are in existence, it has proved extremely difficult to observe any relation between these analytical results and the actual keeping properties of the fruit.

Wallace (1930), summarising from data obtained in experiments at Long Ashton, states "Storage qualities do not appear to show any simple relationship to the content of total nitrogen, titratable acidity, sugars or mineral constituents."

In particular the special effects of cold storage have been found to bear no obvious relation to sugar and acidity losses, (Long Ashton data unpublished) in the case of any given sample, greater losses invariably occurring in an ordinary temperature store than in a cold store at 1° C., though the sample may develop Low Temperature Breakdown prematurely in the cold store while remaining free from breakdown under the conditions of the ordinary temperature store during the same period. It has also been shown at Long Ashton, Wallace (1930), that the order in which samples of apples from high and low potash treatments break down in the ordinary temperature store may be reversed when the samples are stored at 1° C. In view of such facts it has seemed desirable to extend the scope of the analytical enquiry into the storage problem.

The point of view which has dominated the consideration of the metabolism of organs isolated from a plant, is one which was originally put forward by Deleano (1912), and it is based upon the results of his work with vine leaves stored in the dark. Under such conditions of starvation it was observed that the material used up in respiration was at first almost wholly carbohydrates, and only after the carbohydrate supply was seriously depleted was any marked loss of protein observed. Quite obviously in such a case as this, loss of protein will result in the death of the tissues, because the protein may be regarded as the fundamental material

† The investigation reported in this Paper is in connexion with the Fruit Storage Experiments in progress at Long Ashton.

basis of the living protoplasm. It should be observed that it is customary to assume that protein degradation does not occur until after carbohydrate depletion. Deleano's results do not, however, give conclusive evidence on this point and, indeed, in studies on leaves at Leeds, it has been found that the proportion of protein to carbohydrate decomposed may be very greatly affected by the conditions under which the isolated organ is kept.

It does not appear that any serious attempt has been made to apply this idea of protein breakdown to fruit. In apples, the protein is usually less than 2 per cent. of the dry matter as against, in round figures, 75 per cent. of sugars and 5 per cent. of acids. In such a case, any protein decomposition would be dangerous because of the small amount present, yet on the usually accepted view such a decomposition is unlikely to take place early owing to the large amounts of sugars and acids present. When in fact it is found at the time of breakdown of a stored apple, that sugar and acid concentrations are only slightly altered, it has been necessary, in order to explain this breakdown, to introduce some subsidiary hypothesis, such as a failure of the mechanisms by which sugars are activated for respiration. It will be equally evident that it is also necessary to determine whether or not protein decomposition has preceded the time of breakdown and whether this decomposition goes on continuously during the storage life of the apple. If so, it remains to determine whether such a decomposition is affected by differences of storage temperature and of cultural history. It will be obvious that this investigation by no means exhausts the analytical possibilities. The relation of products like the essential oils to breakdown represents, for example, another line of enquiry which may prove to be profitable.

MATERIAL AND METHODS.

The material used consisted of apples, which were very uniform in appearance, of known origin and manurial treatment, on which detailed storage tests were being made at the University of Bristol Agricultural Research Station, Long Ashton. The work was carried out in collaboration with Mr. T. Wallace, of Long Ashton, who forwarded suitable samples at intervals and who supplied the results of the storage tests, and of the analyses at the time of picking. The apples used were partly Bramley's Seedlings, some of which had had cultural treatment giving abundant available potash, while others were from potassium deficient trees. Samples of these two types had been stored at a low temperature (1° C.) and further samples at ordinary temperatures (5 to 15° C.). Four conditions were thus represented. In addition, two samples of Newton Wonder apples were examined representing apples from

treatments giving abundant and deficient nitrogen supply. These samples were stored at 1° C. The types of apples examined and the storage results are summarised below :—

Variety of Apple.	No. of Sample.	Storage Temperature.	Manurial Type.	Time of Breakdown, Type and Intensity.
Bramley's Seedling	90	Cold ..	High K	24% Scald at 190 days.
	94	" ..	Low K	31% " "
	96	Ordinary ..	High K	None observed throughout Test—190 days.
	100	" ..	Low K	do.
Newton Wonder ..	82	Cold ..	High N	49% Severe Scald at 162 days, 85% very severe Core Flush at 200 days.
	81	" ..	Low N	38% Core Flush, mostly very slight, at 200 days

Samples for analysis consisted of 25 apples in the case of the High Potash and 30 in the case of the Low Potash samples, because the latter were smaller fruits. These were taken out of store at Long Ashton and despatched to Leeds, which they reached the following morning. Immediately on arrival they were peeled, the core removed with a large cork borer and three representative samples were prepared. Duplicate samples of a few thin transverse slices from each apple were weighed, dried for half-an-hour at 95° C. and then to constant weight at 65° C. for a week. From these the water content, dry matter and total nitrogen were determined. A second larger sample consisting of nearly half of each apple was pressed until no further juice could be extracted. On the expressed juice, determinations of sap density and of pH were made, the latter being obtained with a quinhydrone electrode and potentiometer, and at a constant time (4 hours) after the treatment was started to make comparable any possible changes of acidity during preparation. The sap was stored under toluol. The third sample, again nearly half of each apple was extracted with 60 per cent. alcohol, in the proportion of 100 ccs. to 100 gms. of fresh apple tissue. On this sample measurements of the forms of soluble nitrogen, sugars and acidity were made.

The nitrogen estimations were carried out using the modified Kjeldahl method to include nitrates. This is probably an unnecessary precaution. Total N (Plant Physiol. 1927, 2,206) was determined on the dried and powdered apple, the soluble N on a fraction of 60 per cent. alcohol extract after evaporation to dryness. The object of using 60 per cent. alcohol was to precipitate the proteins. Apart from proteins of cereal seeds, which are soluble only in 70—90 per cent. alcohol, no plant proteins are known which dissolve in alcohol and Osborne, Wakeman and

Leavenworth (1921) and Vickery (1924) have shown that 55 per cent. alcohol entirely precipitates leaf proteins. For future procedure it would possibly be desirable to use higher concentrations of alcohol (*e.g.* 80 per cent.) in the case of apples to avoid extracting pectic substances, which may subsequently cause turbidity of the solution, and other difficulties. In protein degradation nitrogen is usually assumed to pass into amino-acids which are then supposed to be deaminated to give first ammonia and then possibly other soluble forms of nitrogen. On this assumption it was necessary to estimate Protein N, Amino N, Ammonia N and other soluble N ("Rest N"). We therefore obtained Protein N as the difference between Total N and Soluble N. Amino N was estimated by Sorensen's formol titration method. As this includes also Ammonia N—the Ammonia N was estimated by the aeration method of Van Slyke (see Cole, 1927) using cream of magnesia to neutralise and the values subtracted from the formol titration result. In actual fact, Ammonia N is so small in amount that it could be neglected in future work, as it has no appreciable effect on the Amino N values. "Rest N" was obtained as the difference between Soluble N and (Amino N+Ammonia N). The chief reason for using the formol titration method was that the titration could be run in conjunction with the acidity determinations. In carrying out these titrations it was found to be necessary to use a comparator method, as the colour changes in apple extracts are very considerable. We used that described by Cole (1927) with slight modification, and found it very suitable, and the results easily reproducible. As changes in sugars during the storage life of apples have been fairly thoroughly studied, it was not part of our plan to devote much time to them. For the sake of completeness we give the results of estimations of reducing sugars and sucrose by the picric acid method as modified by Willaman and Davison (1924). The method is rapid and useful for comparative purposes. All the estimations have been done in duplicate and those of Total N and Soluble N often more frequently. By comparison of the replicates and by check determinations in which known quantities of nitrogen were added to apple samples, it is believed that the values for Total N and Soluble N lie respectively within 1.0 and 0.7 mgms. (per 100 gms. of fresh weight) of the true values, and they are on an average more accurate than this. Differences in Protein N of 1.5 mgms. (per 100 gms. of fresh weight) are probably significant. The figures for Amino N+Ammonia N are probably accurate to within 0.3 mgms. per 100 gms. of fresh weight and hence differences of Rest N of more than 1 mgm. are probably significant.

In the table of results which follows, the figures are given as

grams. or milligrams of substance per hundred grams of fresh weight—the nitrogen figures being stated in the smaller unit. The analyses at the time of picking are the Long Ashton determinations :

TABLE I.

Sample.	Days in Store.	% DW.	% Water.	Sap pH Value.	Sap Density.	% Total Sugar.	% Re- ducing Sugar.	% Sucrose.	cc. N. Acid per 100 F. Wt.
No. 69	0	11.50	88.50	—	—	9.32	6.96	2.36	13.891
Bramley's Seedling	79	10.99	89.01	3.05	1.061	9.02	7.57	1.45	12.62
High Potash ..	114	12.30	87.70	3.22	1.041	8.67	7.54	1.13	10.84
Ordinary Store ..	191	11.26	88.74	3.28	1.036	8.90	8.20	0.70	9.934
No. 90	0	11.50	88.50	—	—	9.32	6.96	2.36	13.891
Bramley's Seedling	86	12.28	87.72	3.14	1.045	8.96	6.96	2.00	14.14
High Potash ..	119	11.71	88.29	3.0	1.038	9.28	7.71	1.57	12.80
Cold Store ..	199	11.56	88.44	3.18	1.037	9.07	7.57	1.50	10.12
No. 100	0	11.14	88.86	—	—	9.48	7.62	1.86	10.681
Bramley's Seedling	80	11.54	88.46	2.99	1.050	8.96	7.97	0.99	9.176
Low Potash ..	115	11.49	88.51	2.96	1.042	8.71	7.39	1.32	8.303
Ordinary Store ..	191	11.66	88.34	3.04	1.038	8.71	7.80	0.91	7.067
No. 94	0	11.14	88.86	—	—	9.48	7.62	1.86	10.681
Bramley's Seedling	86	12.32	87.68	3.05	1.052	9.41	7.51	1.90	11.10
Low Potash ..	120	12.47	87.53	2.96	1.040	8.78	7.27	1.51	9.388
Cold Store ..	199	11.50	88.50	3.05	1.040	9.14	7.47	1.67	9.348
No. 82	0	12.55	87.45	—	—	8.83	7.52	1.31	8.309
Newton Wonder	98	12.55	87.45	3.44	1.042	8.38	7.09	1.29	5.596
High Nitrogen	126	12.825	88.125	3.30	1.042	7.93	6.70	1.23	5.606
Cold Store ..	204	11.51	88.49	3.66	1.040	6.74	6.28	0.46	3.813
No. 81	0	13.63	86.37	—	—	9.52	7.99	1.53	6.9815
Newton Wonder	100	14.20	85.80	3.44	1.046	8.76	7.725	1.035	5.335
Low Nitrogen ..	126	14.225	85.775	3.40	1.050	7.77	6.931	0.839	4.436
Cold Store ..	204	12.43	87.57	3.70	1.046	7.37	6.613	0.757	3.401

As per cent. of Fresh Weight.

TABLE II.

Sample.	Mgms. per 100 gms. of Fresh Weight.					Per cent. of Total N.					Days in Store.
	Total. N.	Soluble N.	Protein N.	Amino N.	Ammonia N.	Rest N.	Protein N.	Amino N.	Ammonia N.	Rest N.	
No. 96 Bramley High Potash Ordinary Store	37.5 43.0 51.66 51.3	— 6.28 14.15 18.42	36.72 37.51 32.88	3.74 2.63 3.27	0.18 0.10 0.18	2.36 21.42 14.97	85.4 72.7 64.0	— 8.7 5.1 6.4	0.42 0.19 0.36	— 5.5 22.1 29.2	0 79 114 191
No. 90 Bramley High Potash Cold Store	37.5 41.72 43.0 45.31	— 8.57 14.52 20.35	— 33.15 28.48 24.96	— 3.67 4.42 2.79	— 0.02 0.01 0.04	— 4.88 10.08 17.52	— 79.5 66.25 55.1	— 8.75 10.3 6.17	— 0.05 0.03 0.08	— 11.7 23.45 38.65	0 86 119 199
No. 100 Bramley Low Potash Ordinary Store	44.8 45.67 49.02 52.3	— 11.67 15.71 17.25	— 34.00 33.31 35.05	— 5.13 5.16 4.58	0.14 0.09 0.08	— 6.4 10.46 12.59	— 74.45 67.85 67.0	— 11.25 10.55 8.75	— 0.30 0.19 0.15	— 14.0 21.4 24.1	0 80 115 191
No. 94 Bramley Low Potash Cold Store	44.8 46.81 44.82 47.8	— 15.50 14.46 22.30	— 31.31 30.36 25.50	— 4.74 3.48 4.44	— 0.04 0.09 0.04	— 10.72 10.89 17.82	— 67.0 67.75 53.35	— 10.1 7.75 9.3	— 0.09 0.20 0.08	— 22.9 24.3 37.35	0 86 120 199
No. 82 Newton High Nitrogen Cold Store	42.9 52.8 55.4 59.4	— 17.41 19.42 21.00	— 35.39 35.98 38.40	— 3.58 3.87 3.40	— 0.05 0.05 0.04	— 13.73 15.50 17.56	— 67.0 65.0 64.6	— 6.8 7.0 5.73	— 0.10 0.085 0.062	— 26.1 27.95 29.6	0 98 126 204
No. 81 Newton Low Nitrogen Cold Store	19.0 24.95 22.45 23.04	— 2.67 5.26 18.40	— 22.28 17.20 4.64	— 0.95 0.84 1.14	— 0.06 0.15 0.01	— 1.66 4.27 17.25	— 89.3 76.6 20.15	— 3.81 3.76 4.95	— 0.24 0.67 0.04	— 6.65 19.0 74.85	0 100 126 204

The results of the analyses show nothing of particular interest in regard to sugar and acidity, although they agree fairly well with the conclusions of previous workers. The features of especial interest are naturally those concerning the changes in the nitrogen fractions. Owing to the fact that stored apples lose both fresh and dry weight, any decreases in the N fractions may be masked by the apparent rise in Total N due to the method of expression, *i.e.* on the fresh weight basis. Assuming that the amount of N remains constant the most useful method of expression is to consider the N fractions as percentages of the Total N. It is then apparent that generally the Protein N decreases in proportion during storage, while there is a corresponding rise in the Rest N. The Amino N and Ammonia N remain throughout in roughly constant proportions. It will be evident that in the High N apples (Newton Wonder) the changes in the proportions of the various fractions are barely significant.

In a general way the results clearly indicate that protein decomposition ensues—and that its products accumulate, presumably after passing through the Amino N and Ammonia N stages—as “Rest N” compounds of unknown origin and composition. Further work on the latter is being undertaken.

From the point of view of the causes of “Breakdown” the results are not quite so easy to equate. Of the four samples of Bramley’s Seedling the two which lost the most protein, Nos. 90 and 94, were those which were reported as showing breakdown. It is striking that both of these were stored at the lower temperature (1° C) and that their sucrose and acid contents were still much higher than those of the samples kept at a higher temperature. This certainly suggests that the loss of protein may be the critical factor in the storage history of apples of this variety.

If, however, we are to interpret the results, and assuming that the protein represents the indispensable material basis of the protoplasm, then, there ought to be a lower limit of protein below which death of the tissue takes place. This view could perhaps be supported from the Bramley’s Seedling results. One might expect that this limit would be more easily reached in apples of Low N (and therefore low protein) content, and probably more slowly in apples of High N content—since the amount of protein present would be greater in the latter (Cf Nos. 81 and 82, Newton Wonder) and it would therefore take longer to break down. In actual fact breakdown occurs *earlier* in High N apples and *later* in Low N, although the changes in Protein N are much more marked in the latter case, owing in part perhaps to the smaller amounts present.

Provisionally, then, it must be assumed that breakdown in the High N apples depends on other factors than the changes in protein, and that in general breakdown does not necessarily mean that the total protein has reached a definite lower limit either of quantity or of proportion. Similarly it is unlikely that after a lower limit of sugar content has been reached breakdown occurs, for comparison of the Newton Wonder samples with those of Bramley's Seedling show higher sugar content at the end of storage life of the former than at the beginning of the storage life of the latter samples. Pending further enquiry into these points an alternative line of attack may be suggested. An examination of the table of results shows that all of the samples of apples which had developed breakdown—irrespective of variety—contained more than 17 mgms. of "Rest N" per 100 gms. of fresh weight. Only one of the samples free from breakdown had more than 15 mgms. of "Rest N." This sample (High N, No. 82, Feb. 18th) must, however, have been approaching breakdown since the storage results state that breakdown was prominent 36 days later. This result certainly suggests that breakdown may be associated with the development of a certain critical concentration of "Rest N." The need for a detailed examination of this fraction is again apparent, and it is hoped to report further on this point.

In regard to the physiological questions arising out of the different rates of protein decomposition in the various samples of apples, attention has already been drawn to the differences displayed by High N and Low N apples. We may point out that the High N apples show a consistently greater proportion of soluble nitrogen—particularly Amino N and Rest N. This is quite in agreement with the results of Pearsall and Ewing (1929) on leaves, and it shows that the physiological equilibrium in such tissues tends in the first place towards the hydrolysis of protein.

The varying amounts of available potash (in Bramley's Seedling apples) did not produce, in this instance, any very marked effects on protein decomposition at the low temperature (1°C.). On the other hand, at normal temperatures, a high potash content led to a more rapid rate of protein degradation. It is perhaps permissible to conclude provisionally that at 1°C. the temperature effects predominated—at the ordinary temperature, however, the manurial effects were paramount. It is evident, also, that on the whole, the proportions of Amino N (either as percentages of Total N or in proportion to the protein) tend to be higher in apples deficient in potash, as shown in the following summary. This may, perhaps, be considered to be in general agreement with Doby and Hibbard's results (1927). They found that plants grown under conditions

deficient in potassium (and in other elements) gave increased rapidity of amylase action, as measured by hydrolytic changes. The higher proportions of Amino N in the Low Potash apples could thus be regarded as evidence of an equilibrium tending towards hydrolysis. On the other hand the Low Potash apples also possess higher Total N and in agreement with this, one would expect them to have higher proportions of the soluble forms of nitrogen.

AVERAGE AMINO N VALUES AS PER CENT. OF:

			Total N.	Protein N.
High K	Ordinary	.. ..	6.73	11.5
" "	Cold	.. ..	8.41	12.7
Low K	Ordinary	.. ..	10.18	14.55
" "	Cold	.. ..	9.05	14.60
High N	Cold	.. ..	6.51	9.93
Low N	Cold	.. ..	4.17	4.58*

* On first two dates. On the last date the figure was 24.6.

It may be concluded that the enquiry into the nitrogenous constituents of stored apples promises an interesting extension of the available analytical methods. There are evidently decided changes in the Protein N and Rest N fractions during storage, and these changes appear to show a general parallel with the development of breakdown as well as with differences in the storage conditions and in the internal conditions induced by previous manurial treatment. Further work is needed to show whether it is possible to generalise on these apparent relationships. It seems clear, however, that protein degradation is progressive during the storage life and that it may be more rapid at 1°C. than at ordinary storage temperatures.

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EXAMINATION OF PLANTS FOR INSECTICIDAL PRINCIPLES, II.*

ELECAMPANE.

BY F. TUTIN.

The wild plant, Elecampane (*Inula helenium*), has, from the very earliest times, been reputed to possess medicinal properties, but its use in this connection has now largely died out. In many quarters, however, Elecampane flowers are regarded as being inimicable to insects and a number of apparently well-founded instances of their power of preserving clothing from damage by the "Clothes Moth" have been brought to the author's notice. It was therefore deemed desirable to ascertain whether these flowers contained any principle toxic towards insects, as is the case with *Pyrethrum* flowers. With this object in view a quantity of Elecampane flowers was kindly supplied to us by Mr. Winstone, of the Home Farm, Butleigh, Glastonbury, to whom our thanks are due.

The flowers, after drying in the air, were ground, and then extracted in a Soxhlet apparatus successively with light petroleum, ether, and alcohol. The alcoholic extract was subsequently divided into portions soluble and insoluble in water respectively. The petroleum extract, the ether extract, and the portion of the alcoholic extract which was insoluble in water were each of them emulsified with the aid of Agral W.B., the resulting emulsions being sprayed on to nearly fully-grown larvae of the Birch Mocha moth, *Ephyra pendularia*. In no case, however, were any of the larvae killed, even when using emulsions representing a concentration of from 10 to 20 per cent. of the original flowers, whilst a similarly prepared emulsion of the petroleum extract of *Pyrethrum* flowers caused the death of all the larvae when used in a concentration representing only 0.5 per cent. of the respective flowers.

Similarly negative results were obtained by spraying the larvae with the material from the above-mentioned alcoholic extract which was soluble in water and with an aqueous infusion of the original, dried and ground flowers.

It must therefore be concluded that the flowers of Elecampane do not contain any principle toxic to insects. Their deterrent action with regard to infestation by clothes moths may, in all probability, be ascribed to the volatile substance of camphoraceous nature which is known to be present in the plant, and which may well be repellent to insects without necessarily being toxic to them.

* See this Report, 1929, p. 96, for Part I.

NOTES ON SOME AGRICULTURAL AND HORTICULTURAL PESTS IN THE BRISTOL PROVINCE.

I.—THE BEET CARRION BEETLE (BLITOPHAGA OPACA) AND ITS CONTROL.

BY L. N. STANILAND AND C. L. WALTON.

This insect is not of very general occurrence, but now and again causes serious losses amongst young mangolds or sugar beet. A number of such cases have been brought to our notice recently. One, in particular, of which we were first informed by Mr. J. C. F. Fryer, M.A., of the Ministry of Agriculture, in 1929, has been of a particularly severe and persistent type, losses having recurred over a period of five or six years, whilst neighbouring crops have been affected from time to time.

The Life History of the Beetle.

The life history is usually given in textbooks as follows:—The adult insects hibernate in the soil, etc., become active in spring and lay their eggs. The resultant larvae feed for about three weeks on the leaves of the young mangold or beet plants and then pupate in the soil, hatching in due course. They are stated to feed also on weeds belonging to the Chenopodiaceae.

The natural habitat of these beetles appears to be the neighbourhood of woodlands.

Several similar species of beetle are frequently to be found on "carrion," such as small dead animals or birds, and may be confused with the present species which feeds on both carrion and plants.

Attention may be drawn to Figure I, where the adult beetle and the active black larva are figured.

The Lydney Outbreak.

The outstanding case above mentioned was near Lydney, Glos., on the borders of the Forest of Dean. The field chiefly affected is situated at an elevation of 300ft., the soil being light loam over Old



FIG. I.—Beet Carrion Beetle (*Blitophaga Opaca*).

1. Adult Beetle ($\times 2$ approx.)
2. Larva ($\times 2$ approx.)
3. Damage by larvae to mangold leaf.

Red Sandstone ; it has a moderate slope, and is practically surrounded by woodlands. This field and a similar smaller one adjoining are the only plough land on the farm, and in consequence mangolds are grown on part of them every year, the rotation being one-third roots, one-third oats and one-third ley. It will therefore be seen that the sites of these crops of mangolds have been year after year in close proximity.

The land was in good condition and well suited to the crop, the few remaining plants being healthy and well grown. Heavy dressings of lime had been applied without having any deterrent effect. Carrion crows had been noted as feeding on the larvae.

At the time of the first visit (July 29th, 1929,) both adult beetles and larvae were present and fully 90% of the young plants on threequarters of an acre of mangolds had been destroyed, despite the fact that great numbers of the larvae had been hand picked and destroyed. Not only had the leaves of the plants been eaten but their stalks also. Other crops were not affected. An interesting feature was the presence of deep holes or galleries in the vicinity of the attacked plants, down which the larvae disappeared when alarmed.

In 1930 a series of experiments on the control of the pest was arranged. The worst affected part of the field was divided into four plots treated as follows :—

- Plot (1) *Arsenate of Lead Dust*—applied three times, once just before attack was expected and twice thereafter.
- „ (2) *Arsenate of Lead Dust*—applied after attack began.
- „ (3) *Whizzed Naphthalene*—broadcasted, both before and after attack.
- „ (4) Control plot.

The first larvae were noted on June 7th, and the plots were visited for detailed observation on the 11th. The following results were observed.

Plot 1. On the plot dusted with lead arsenate prior to the appearance of the larvae, no injury had taken place.

Plot 2. On the plot dusted after attacks had commenced, the plants were only slightly damaged.

Plot 3. Naphthalene had not prevented the plants from being injured.

Plot 4. The control plot was very severely attacked. It was

noted that common spurrey growing as a weed on this plot had also been attacked to some extent. Part of this plot had been dusted with arsenate after severe injury had been done and dead larvae were noted during the visit.

It would appear from the above experiments that infestations of *B. opaca* can be either prevented or held in check by the application of arsenate of lead dust early in June.

For a possible alternative method of control the following reference is of interest :—

In the "Monthly Summary of Plant Pests and Diseases in England and Wales" for 18.8.30 (issued by the Ministry of Agriculture and Fisheries) this pest is recorded by Mr. H. W. Thompson, Advisory Entomologist for the South Wales Province, as being controlled during June as follows :—"The plants were rolled in the early morning and a dressing of soot given. Many of the larvae were killed and no further damage took place."

Rolling, therefore, in the early stages (as recommended for Mangold Fly) would appear to be worth trial.

II.—A CASE OF SAINFOIN MIDGE (*CONTARINIA* *ONOBRYCHIDIS* KIEFF) IN WILTSHIRE.

BY L. N. STANILAND AND C. L. WALTON.

During the summer of 1929 some specimens of this pest were received from Wiltshire, whilst further examples were sent in during 1930, by Mr. W. T. Price, Agricultural Organiser for the County. A visit subsequently paid to the Warminster district on July 15th sufficed to show that the sainfoin, which is extensively grown on the hill land thereabouts, was infested to a quite considerable extent.

In view of this, it is considered desirable to draw attention to this pest, which may become a serious menace to growers of sainfoin.

The insect, first described by Kieffer in 1895, belongs to the Cecidomyiidae or Gall Midges, many of which are of economic importance.

The first British record seems to have been in 1917, from the eastern counties (1). Barnes (2) refers to this and mentions the



1

2

Sainfoin plants showing injury by *C. onobrychidis*.

1. Affected flowers.

2. Loss of seed pods.

occurrence of the pest on the continent: after quoting Kieffer's description he states "The larval stage of this midge attacks the flowers of sainfoin (*Onobrychis sativa*). The flowers are swollen and remain closed. No seeds are formed. The larvae are gregarious and citron yellow or white in colour. Little, however, is really known concerning this pest."

The Pest in Wiltshire.

How widespread this insect is in Wiltshire is as yet uncertain, but during the visit on July 15th it was detected over quite an extensive area where 10% of flowers heads were then found to be infested on one field, from 50 to 60% of the seed pods on such stems being thereby prevented from seeding. At the time of this visit many of the infested flowers had fallen, leaving bare areas on the seeding stems. The accompanying photographs, taken from specimens gathered on that date show (from left to right) (1) infested swollen flowers and (2) seeding heads showing gaps where infested flowers had fallen.

Control.

In a letter to the authors, Dr. Barnes states "No control has yet been worked out for this pest and very little is known about it. The grubs stay in the flower heads for a short while in the summer, and then jump to the soil where they pupate. (If the crop is not grown for seed I should imagine the pest is not very serious.) If the crop is grown for seed, all I can suggest is that as soon as the pest is seen to be present, the crop should be cut (perhaps used as fodder) and then allowed to flower again and this time the seed should be free from attack. This sort of control is used in America against a midge whose grubs eat red clover seed." Dr. Barnes adds, however, that it is not certain if there is a second brood.

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- (1) Report on the Occurrence of Insect and Fungus Pests in England and Wales in the Year 1917, Bd. of Agric. & Fisheries, London, Misc. Publ. No. 21.
 (2) Barnes, H. F. "British Gall Midges of Economic Importance." Jnl. S. East. Agric. Coll., Wye, No. 24, July 1927, p. 97.

III.—NOTES ON A SERIOUS TOMATO PEST (SCUTIGERELLA IMMACULATA).

BY C. L. WALTON.

INTRODUCTION.

During 1928 the attention of the writer was drawn to the seriously stunted condition of tomato plants growing in a range of commercial glasshouses. Shortly after this another similar case was reported, and later a third was discovered. Three counties in the Bristol Province are concerned, namely, Somerset, Wilts, and Hereford. One case was of long standing, another less so, whilst the third had only become serious during the previous year. All the growers concerned were experienced and capable, and previously had been successful with their crops. These cases were of a most serious character, entailing the failure of the crop in entire houses and, being of an obscure nature, are evidently not always related to their real cause. Furthermore, from information received, it would seem that this trouble is by no means confined to the cases mentioned here, but occurs in other tomato growing areas.

THE CAUSE OF INJURY.

Investigations were set on foot, and soil from various depths was examined *in situ* and in the laboratory, whilst samples of affected plants were also obtained, together with all the information the growers were able to supply. It was obvious that the young plants commenced their growth in a perfectly healthy condition and speedily became unhealthy and stunted after being set out in the affected "borders." Examination showed that in such plants the root hairs had been eaten away in varying degrees; in the worst cases they had been wholly removed, and plants thus damaged in due time died away: the nature of the damage suggested the presence of some form of insect pest in the borders.

It was some time before the real delinquent was ascertained since a series of different creatures of close resemblance inhabited the soil of these houses. In one sample there were considerable numbers of immature Millepedes, undoubtedly harmful; in another, a fragile primitive wingless insect *Campodea lubbockii* was present, whilst sundry other small "Springtails" (Collembola) occurred in most samples. However by far the most abundant and widespread species was *Scutigerella immaculata*: individuals of this form literally swarmed about the roots of the plants in the affected

borders during the growing season; they retire to subsoil levels during the winter season.

There seems no doubt that, although Millepedes and *Campodea* may be responsible for root injuries, the particular type of injury to which notice is here drawn—the wholesale destruction of root hairs—is due to *Scutigera*.

S. immaculata is a very fragile creature which moves through the soil with great swiftness and is very difficult to handle or transport. It bears a strong superficial resemblance to both *Campodea* and to immature "Millepedes" with both of which it is undoubtedly confused by many observers. It belongs to a little known group, the "Symphyla," recently dealt with by Dr. Brade-Birks (1), who describes them as "A class of soil-dwelling Arthropoda, it forms with Diplopoda (Millepedes q.v.) and Pauropoda (q.v.) the Super-class Progoneata. Symphyla comprise but one family, the Scolopendrellidae. The white body, never more than eight mm. long, is invested with thin chitin and consists of a distinct head with one pair of many jointed antennae and an elongated trunk bearing 12 pairs of legs, of which the first is often reduced. At the hind end of the body are a pair of backwardly directed conical appendages, the cerci, which function as spinning organs.

(1) Rev. S. Graham Brade-Birks, D.Sc. "Encyclopaedia Britannica." 14th Edn., Vol. 21. 1929, p. 705.

"Symphyla have been described from all the continents of the globe. They are occasionally injurious to the delicate tissues of cultivated plants" (1).

Brade-Birks in another recent article (2) deals with the "Economic Status of Symphyla," and quotes a series of observations on various cases of plant damage, several of which refer specifically to *S. immaculata* in America and France. After quoting Theobald (1912), who mentions the occurrence of a Symphyle in Guernsey associated with "considerable damage . . . done in the glass-houses . . . to tomatoes, etc.," he sums up ". . . it would appear that attacks of Symphytes are rare on this side of the Atlantic and from anatomical evidence we should expect none but very soft tissues, or parts of plant cells otherwise exposed, to be attacked."

(1) C. Attems in Handbuck der Zoologie IV, p. 11 (1926). See also Revue de Zoologie Agricole, Bordeaux, Sept., p. 192, 1925.

(2) Brade-Birks' "Notes on Myriapoda XXXIII." "The Economic Status of Diplopoda and Chilopoda and their Allies." Journ. S. East. Agric. College, Wye, No. 26, July 1929, p. 188.

Attempts to breed these creatures in the laboratory and to get them to cause injury to tomato seedlings failed, it being evidently impossible under the conditions used to obtain the right degrees of moisture, temperature, darkness, etc., necessary for them.*

CONTROL MEASURES.

So far, these have been limited to attempts made by some of the growers themselves, but have nevertheless included some vigorous, ingenious and sustained efforts in that direction. The author has made certain suggestions and these are under trial. One grower soon discovered that if he removed stunted plants to pots free from the pest, root-hairs were soon formed and growth recommenced; these plants transplanted again to infested borders speedily reverted to their former condition. Plants potted out with their roots and soil enclosed in grease paper bags continued to grow until the paper decayed and a wholesale use of containers (and even newspapers) was resorted to and enabled the plants to gain size (and hence greater resistance) before becoming subject to attack.

It has also been found that soil treatment, in order to be of value, must precede the crop, and that during such time the mass of the Symphytes are situated at depths down to three feet (depending upon temperature and the depth at which a "subsoil" is reached). The worst injury usually occurs in "patches," which vary in size and site from time to time. Deep trenching to expose the subsoil, which is then dressed with soot, or other substances, has given good results, but is very expensive: in one case an overdose of soot led to unsuitable growth in the crop. This method is being further experimented with, using calcium cyanide, naphthalene and other substances as soil fumigants.

SUMMARY.

Several cases of a characteristic form of tomato plant failure in the Bristol Province have been investigated.

Scutigerella immaculata, a fragile, soil-dwelling member of the Symphyla, appears to be the causal organism associated with the trouble, feeding upon the root hairs of the plants and thus inhibiting their growth.

The habits of this pest render its control a matter of difficulty, but it is hoped to be able to devise some means which will render this less expensive and laborious.

* I am indebted to Dr. Brade-Birks for examining specimens from the affected glasshouses in this province.

OBSERVATIONS ON CAPSID BUG CONTROL BY MEANS OF "HIGH NEUTRAL" TAR DISTILLATE WASHES IN 1930.

BY L. N. STANILAND and C. L. WALTON.

INTRODUCTION.

The investigations on tar distillate washes which have been in progress at this Station for several years have resulted in the evolution of the form of wash commonly known as the high-neutral two-solution type. The method of preparing spray mixtures of this type was first published in a paper by Tutin (11). A special feature of the wash is its efficiency for the destruction of the eggs of the Capsid Bug, *Plesiocorus rugicollis*, one of the most serious of all apple pests, as demonstrated by the trials of 1928 and 1929 (1, 2 and 3). It is also highly toxic to the eggs of other common pests of the apple, such as Winter Moth, Apple Sucker (*Psylla mali*), and the various apple Aphids. It has been ineffective hitherto, however, in respect of Red Spider eggs.

In continuation of these investigations, the field side of the 1930 programme was mainly centred round the two outstanding points indicated in the previous paragraph, viz., the efficiency of high-neutral two-solution wash for Capsid control and its inefficiency for Red Spider control.

Conclusions drawn from laboratory trials with a large number of preparations (4) suggested that a more efficient wash might be prepared by incorporating a heavy paraffin oil with the high-boiling neutral tar distillate previously employed. Small field trials with such a mixture were therefore conducted in 1930 and are being extended in 1931. It is not the purpose of the present paper to consider them in detail, the trials being still incomplete; but this passing reference is called for, since this new variant of the wash, in addition to being very hopeful for Red Spider control, appears to have enhanced Capsid control properties. Consequently it is being used extensively for the 1931 programme, the older type being included only to serve as a basis for comparison.

The present paper is concerned primarily with the 1930 trials with the older type of the wash—the high-neutral two-solution form. The extremely satisfactory results of the 1928 and 1929

trials gave ground for anticipation that it might be possible to exterminate for practical purposes the Capsid pest in affected orchards. The 1930 trials were designed chiefly to test that point of view, two main centres, Birlingham and Hampton, both in Worcestershire, being selected for the purpose. A supplementary test at Wilmington, Kent, was also included, since it was there that the only case of partial failure occurred in the 1929 trials. In this instance the main objective in 1930 was not the extermination of the pest, as in the other two instances, but a test of the possible influence of an undetermined local factor reducing the efficiency of the wash. This difference in the objectives at the Worcester-shire and Kent centres calls for separate consideration of the results in the respective cases.

The variable nature of these results and of those obtained by the many growers who for the first time used commercial preparations of this form of wash in 1930, have led the authors to conclude this paper with a critical review designed to throw some light upon their diversity.

THE BIRLINGHAM AND HAMPTON TRIALS.

At these centres two orchards, each about two acres in extent, and well isolated from the other plantations, were selected. In one (the Hampton centre), smaller scale trials had been carried out in 1929: in the other (Birlingham), observations and counts to indicate the degree of infestation had been made in that year. In the latter case no treatments effective for the control of Capsid Bug had previously been applied. Information as to the natural incidence of Capsids was thus available. It was therefore unnecessary to leave any trees unsprayed as controls, and in fact the plan of the experiment would have been vitiated, had any trees been reserved without treatment. Further, it is recognised that once the Capsid Bug has become firmly established in an orchard, the degree of infestation tends to remain relatively constant.

The treatment and other details relating to the centres were as follows:—

Centre I. Birlingham, Worcs.

Number of Trees in Trial—265.

Varieties—Worcester Pearmain, Cox's Orange Pippin, Bramley's Seedling and James Grieve.

Spray Treatment—"High Neutral" tar distillate wash (two-solution) at 10% strength.

Date of Application of Spray—January 29th, 30th and 31st, 1930.

The spray was applied by means of a power sprayer, during satisfactory weather at the outset, but with high wind and some rain in the later stages.

Centre II. Hampton, Worcs.

Number of Trees—300.

Varieties—Rival, Lane's Prince Albert and Bramley's Seedling.

Spray Treatment—As at Centre I.

Date of Application—January 28th, 29th and 30th.

Weather conditions as at Centre I.

The spray was applied by means of a headland sprayer.

Counts were made by means of tally registers of samples of 1,000 trusses, and young and mature fruits respectively, the samples being taken at random, except in the case of mature fruits, where trees were taken at random and the entire crop examined. In these latter cases, it was found during the progress of the enumeration on September 15th that a considerable amount of late fruit marking had taken place. In the latest counts of the season, therefore, the fruit of the varieties Cox's Orange Pippin and Bramley's Seedling was separated into three grades, namely, "clean," "early marked" and "late marked" respectively, in order to indicate approximately the part of the growing season at which the attack on the fruit occurred.

In taking the final counts all these markings had to be included, although most of the apples were of a marketable nature and not seriously affected in commercial value.

It may also be noted that at both centres in both 1929 and 1930 the crop of fruit was good for all varieties concerned in the trials.

TABLE I.
Percentage of Fruit Marked by Capsid Bug.

Variety.	Season 1929.		Season 1930.
	Control Plot.		Plot sprayed with "High Neutral" Tar-distillate wash (two-solution).
	Sprayed with old-type tar- distillate washes	Unsprayed.	
<i>Centre I.</i>			
Worcester Pearmain ..	63	—	32.8
Cox's Orange Pippin ..	58	—	24.5
Bramley's Seedling ..	32	—	29.5
James Grieve ..	72	—	43.8
<i>Centre II.</i>			
Rival	68	—	81.9
Lane's Prince Albert ..	—	70	25.5
Bramley's Seedling ..	42	—	27.4

The following table (Table II) shows the successive percentages of Capsid markings on the trusses and fruit at different stages of development throughout the season.

TABLE II.
Progress of Infestation during the Season (1930).

Variety.	Percentage of Trusses Marked by Capsid Bug.	Percentage of Young Fruit Marked by Capsid Bug.	Percentage of Mature Fruit Marked by Capsid Bug.
<i>Centre I.</i>			
Worcester Pearmain ..	(May 14-15) 1.2	(June 14) 12.0	(Sept. 15) 32.8
Cox's Orange Pippin ..	(") 1.0	(") 9.2	(Oct. 6) 20.4 early marked, 4.1 late marked.
Bramley's Seedling ..	(") 0.9	(") 6.6	(") 19.2 " " 10.3 " "
James Grieve ..	(") 2.2	(") 15.6	(Sept. 15) 43.8
<i>Centre II.</i>			
Rival ..	(May 14) 1.1	(June 13) 11.6	(Oct. 1) 65.6 early marked, 16.3 late marked.
Lane's Prince Albert ..	(") 0.3	(") 9.7	(") 15.2 " " 10.3 " "
Bramley's Seedling ..	(") 2.1	(") 15.3	(") 15.2 " " 12.2 " "

Tables I and II show the extent of the infestation at the respective centres, the figures for mature fruit for 1929 being included in Table I for purposes of comparison.

Table III which follows, contains data selected from and typical of the results obtained in the 1929 trials.

TABLE III.
RESULTS OBTAINED IN 1929 TRIALS.*

Centre.	Variety.	Percentage of Trusses Marked by Capsid Bug.		Percentage of Young Fruits Marked by Capsid Bug.		Percentage of Mature Fruits Marked by Capsid Bug.	
		Unsprayed.	Sprayed.	Unsprayed.	Sprayed.	Unsprayed.	Sprayed.
Croptorne (Wores.) ..	Lane's Prince Albert ..	30	Trace	66	6	90	11
Hampton (Wores.) ..	Prince's Pippin ..	76	0	55	5	90	8
Newnham (Glos.) ..	King Edward VII. ..	23	0	66	4	60	11
Topsham (Devon) ..	Lane's Prince Albert ..	40	Trace	90	Trace	65	2

*"High Neutral" Tar Distillate Wash (two solution) at 10% strength used at each Centre these Trials.

It will be seen from the above Tables that the results for 1930 were by no means as satisfactory as those obtained in 1929. A discussion on this point and its possible significance follows later in this paper.

THE WILMINGTON TRIAL.

At this centre the results in the 1929 trials were, as stated in the Introduction, in marked contrast to those obtained at the other centres utilised, and showed a very low degree of Capsid control.

Since it was considered possible that some undetermined local factor was responsible for the failure to secure the high degree of control obtained elsewhere, the block of trees sprayed the previous season was again taken in hand. Only one spray was employed, namely, the "high neutral" (two-solution) tar-distillate wash. The varieties sprayed included Grenadier, Lord Derby, Cox's Orange Pippin and Bismarck. 120 trees in all were sprayed and in addition 12 were left as controls.

The spray was applied at 10% strength on January 23rd by means of a power sprayer, the weather at the time being favourable. In order to ensure beyond question on this occasion complete and thorough emulsification rain water was used instead of the local supply.

Results.

In spite of the precaution just mentioned, the results were again unfavourable. The first counts were taken in early July, and we are indebted to the grower concerned for making them and for supplying the following figures.

TABLE IV.
RESULTS AT WILMINGTON, 1930.

Treatment.	Variety.	Percentage of Young Fruits Marked by Capsid Bug.
Control	Grenadier ..	92.4
"	Lord Derby ..	94.8
" High neutral " wash at 10% strength.	Grenadier ..	10.5
"	Lord Derby ..	99.5

The control trees were severely attacked by caterpillars, resulting in a very small crop of fruit as compared with those sprayed, and this

fact may have affected the severity of the Capsid infestation on these trees.

One of us made an examination on August 29th, 1930, the total crop being examined from 4 trees selected at random, and it was then found that the mature fruits of the variety Lord Derby were 100% marked by Capsid Bugs on both sprayed and unsprayed trees alike. On the variety Grenadier the percentage of marked fruit on the sprayed trees had risen from 10% as shown by the July count to 51%, whilst on the controls the figure reached 90%.

On the remaining two varieties, Cox's Orange Pippin and Bismarck, the crop was too light to furnish results of any value.

DISCUSSION AND ANALYSIS OF POSSIBLE CAUSES OF VARIABILITY OF RESULTS.

In view of the foregoing data it must be concluded that tar-distillate washes of the "high neutral" two-solution type failed to show the consistency in efficiency of the results which the experience of the previous seasons' trials had given ground for anticipation, and therefore some consideration of the possible causes of variability is called for. That more than one factor has been responsible appears highly probable, as the following discussion of the individual possibilities will show.

In this review of possible causes of failure, it will be necessary to refer to instances in which the quality of the wash used or the mode of application must be held responsible. It must be emphasized that such reference is not made with the intention of attaching blame to any spray fluid manufacturer or grower. The object of the review is a critical examination of general experience with this type of wash in its first year of wide use in order to ascertain the reason why the results in many cases fell below the standard of earlier trials. To present the case fairly account must be taken of the incidence of the human factor as well as others.

In spite of the possibility that these two factors could be held responsible jointly for the variability in results experienced in 1929-30, it is the authors' considered opinion, after extensive enquiries and a wide personal survey of results in the field in all the chief fruit areas, that at least one further factor is concerned, which for convenience may be referred to as the seasonal factor.

During the past season it became abundantly clear that there was a very definite tendency for tar-distillate washes of all types to show a somewhat reduced efficiency as compared with that of the two previous years.

To avoid complicating the issue, attention here will be confined to the case of washes of the "high neutral" type.

Before the factors mentioned are discussed in detail a summary of ascertained results obtained by growers themselves may be given to indicate the general position.

The general experience of growers using this type of wash for the first time in 1929-30 was of a very varied character. In the majority of cases results satisfactory from a commercial standpoint seem to have been obtained. In certain instances, indeed, the standard of efficiency of the washes proved equal to the best results obtained during the field trials of 1928-29. In others, whilst satisfactory, there was, as already stated, a slight diminution of efficiency. In certain other cases, however, more or less complete failure to control *Capsis* Bug resulted.

In the face of these divergences, some of which occurred under conditions which appear to be beyond criticism, there seems a *prima facie* case for assuming the intervention of some special factor militating against the efficiency of the wash in 1929-30. In an attempt to ascertain its nature a considerable amount of information not recorded in the description of the trials given above has been collected and will be referred to in the following discussion on seasonal influence in its various aspects.

(A) SEASONAL INFLUENCE.

(i) *The 1929-30 Season in Relation to Bud Damage.*

The winter of 1930 (January-March) was in marked contrast to the previous one, the mean temperature for January at Long Ashton being 7°F. above the average for that month. Excessive humidity, added to the mildness of the atmosphere, encouraged the movement of sap; buds on most trees were noted to have moved abnormally early, even in exposed situations. During February the mean temperature was 6°F. less than in January, and the rainfall was very low in comparison. Consequently buds remained stationary throughout the month. The first half of March was mild, but from the 17th the temperature fell to as low as 13°F. on the 20th: rainfall for the month was slightly under average.

It will thus be seen, that bud movement had commenced as early as January, and that a frost sufficiently keen to cause injury occurred during March.

These circumstances may be held accountable for the bud damage referred to, which thus was due in part to the effect of the washes on buds not absolutely dormant and in other cases to direct frost injury.

(ii) *Review of Past Results on Capsid Control in Relation to Season.*

In the examination of past seasons' results in relation to Capsid Bug control by means of tar-distillate washes generally, a somewhat striking correlation between the results obtained and the general characters of the winters is apparent. Over the period from 1924-1930 it is notable that less successful results have followed the mild, humid type of winter than when relatively dry, cold conditions have prevailed.

In the former category may be placed the winters of (a) 1924-25, when no Capsid Bug control was obtained with washes of the old type (total distillates), (b) 1926-27, which showed similar results, and (c) 1929-30, when, as just stated, inferior results followed the application of the superior "high neutral" washes.

Contrasted with the above was the winter of 1925-26 when promising results were obtained with washes of the old type applied late: the weather during this winter was moderately wet and rather cold. Successful results followed the use of "high neutral" washes during 1927-28 and 1928-29; the former winter was cold and somewhat wet, and the latter cold and dry. The best results of all were obtained during 1928-29.

It will be observed that there is a general agreement between the type of winter and the degree of control effected, mild and wet winters tending to lessen the efficiency of tar-distillate washes, cold and dry winters to increase it. It may also be noted that in the evolution of these washes the tendency has been to develop in the direction of increasing rain resistance until, at the present moment, the newest type referred to in the Introduction—the tar-distillate—heavy paraffin wash—leads the way in this respect.

(iii) *Humidity in Relation to the Control of Capsid Bug.*

Lees and Staniland (8) have shown that rain falling after the application of tar-distillate washes of the old type (even after drying) will affect the kill of eggs very adversely. The use of the "high neutral" washes has reduced this rain effect to a minimum but even during the past season cases have been investigated where rain fell before the wash had time to dry out. In one case of special interest the drying of a block of trees was slowed down by reason of a high windbreak situated on the windward side; poor results in Capsid control followed on those trees most influenced by this windbreak. (This suggests that it is important that spraying should not be continued up to the onset of rain.)

Apart, however, from the direct washing effects of rain following

the application of the washes, the possibility that atmospheric humidity may also affect results must not be overlooked.

The effect of relative humidity (the degree of saturation of the atmosphere) has engaged the attention of various ecological workers.

Paine (9) has shown recently that in America Tussock Moth eggs, kept in a low relative humidity, do not hatch. Whilst too much correspondence cannot be presumed, this worker's investigations may throw light on the Capsid control problem. It will be realised that the effect of a film of tar or other oil over the egg must bring about the equivalent of a low relative humidity. Hitherto, it has probably not been possible to exclude completely all moisture from the eggs. When the atmospheric humidity is relatively high, moisture may penetrate the film to a sufficient degree to enable some eggs to hatch which would otherwise not have done so.

Thus it would appear that the degree of wetness of the winter in this country, since really low temperatures are rare, may have a definite effect on the efficiency of washes of this type and the 1929-30 results in relation to those of previous seasons may be accounted for, in part at least, in that way.

(iv) *Seasonal Variations in the Life-history and Habits of Capsid Bugs.*

(a) *Plesiocoris rugicollis*. During the progress of the counts in connection with the field trials of 1930 it became clear that deviations from the normal in the behaviour of Capsid Bug were taking place.

When the second series of counts, namely, that on young fruit, was made in mid-June, 1930, it was found that the figures of damage then obtained were even higher, in comparison with the leaf counts of the first series, than those of 1929. At that date (June 13th and 14th) a considerable proportion of the Capsid Bugs (*P. rugicollis*) then present had already become winged and, contrary to their usual habits, were obviously still causing fruit injury: at the corresponding period in previous years very few winged forms were observed.

In previous years the authors found that the percentage damage figure from the counts on young fruit at approximately that date agreed within narrow limits with that of the final counts made on mature fruit at the end of the summer. In 1930, however, the latter figure showed a marked increase.

PLATE I.



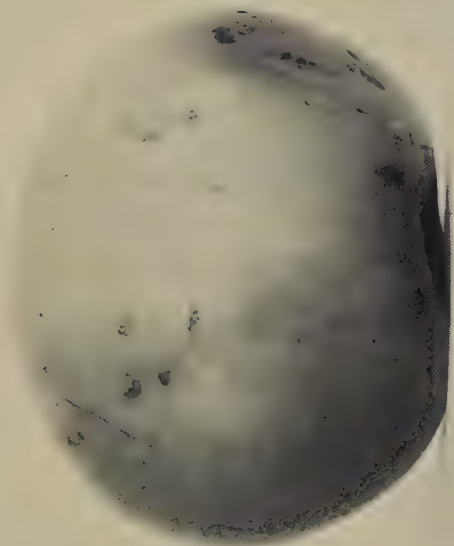
1.



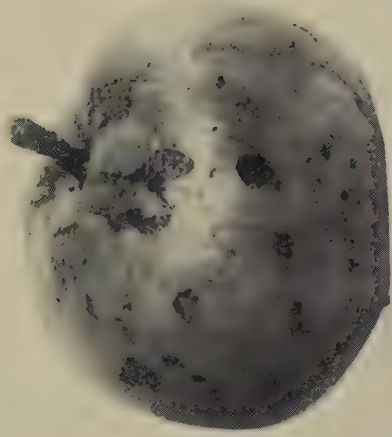
2.

Apples of the variety James Grieve. 1. Late marking by Capoid Baga. 2. Typical early marking caused by *P. rapae*.

PLATE II.



1.



2.

Apples of the variety Bramley's Seedling. 1. Late marking caused by Capsid Bugs. 2. Typical early markings caused by *P. rugicollis*.

Moreover, the final counts showed that a gradation of markings was present, ranging from the usual injuries due to the feeding of the bugs prior to mid-June through similar but smaller and less developed markings to punctures made when the apple had almost finished growth, but too late for the skin to break and produce the typical Capsid markings. In very many of these cases these very late markings would not have been recognised with certainty as due to Capsid Bugs, had it not been for the close observation maintained throughout the whole of the summer.

(b) *Lygus pabulinus*. The possibility that, in addition to ordinary Apple Capsid (*P. rugicollis*), the common Green Capsid Bug (*Lygus pabulinus*) may have caused similar fruit injuries cannot be overlooked. Strong circumstantial evidence has been noted by other observers. For example, Rostrup and Thompson (7) state that *L. pabulinus* "suck young apple fruits in Denmark." Petherbridge (6) also states: "The writer has seen very little damage to fruit which could be attributed to this pest in the orchard; but, in 1928, a number of young bugs from gooseberries were put on some pot apple trees, and have caused brown spots and scars on the apples similar to those caused by the Apple Capsid Bug. This bug, therefore, is capable of marking apple fruits, although it apparently does so very little in orchards."

(c) *Migration*. A case furnishing strong circumstantial evidence of fruit injury due to migrating bugs was afforded by the following example: A block of black currants heavily infested by *Lygus pabulinus* (which is almost invariably accompanied by *Plesiocoris rugicollis*) lay between two blocks of apples. The variety on one side was Cox's Orange Pippin and on the other Charles Ross. The apples were sprayed with a "high neutral" wash at 10% strength, as also were the black currants, under favourable conditions. In accordance with previous experience the apples were practically free from leaf injury whereas a large number of the bugs hatched on the black currants, causing typical injuries. Later on, young fruits were seen to be damaged on the apples of the varieties Charles Ross and Cox's Orange Pippin which lay on either side of the black currants. The damage amounted to approximately 30% of marked fruits on the rows next to the black currants, decreasing greatly on subsequent rows until four rows away from the currants injury was practically non-existent.

It was not possible, owing to the date at which the case was reported, to determine the proportionate numbers of the species of Capsid Bug involved.

(d) *Change of Host.* Another well-known instance of change of habit of apple Capsid Bugs in relation to varietal susceptibility to injury is the case of the variety, Bramley's Seedling. During the early stages of work on Capsid Bug on apples, this variety showed itself to be relatively free from attack as compared with many other varieties. At the time it seemed that the growing of this variety might offer a possible means whereby Capsid attacks might be avoided to some extent.

Capsid Bug has attacked this variety to an increasing extent until, at the present time, Bramley's Seedling appears to be little less susceptible to injury than most other varieties.

(e) *Seasonal Variation in the Control of Capsid Bug on Different Varieties of Apple.*

During the progress of the work, in the past two seasons, it has become evident that the Apple Capsid Bug is definitely more difficult to control by means of tar-distillate washes on the variety Lord Derby than on any other so far examined. This has been especially well illustrated by the trials carried out at Wilmington and Crockenhill (Kent) referred to above. Observations to the same effect have been made on other plantations in various districts.

In the case of the large scale trials of 1929-30, already described earlier in this article, further varietal differences have been noted. With the exception of the variety Lord Derby, such differences had not previously been obvious. Thus, a poorer control of Capsid Bug was obtained on the varieties Worcester Pearmain, James Grieve and Princes Pippin than in the previous seasons. Further, this lack of uniformity in varietal results varied somewhat from orchard to orchard. On the other hand, in the case of the varieties Lane's Prince Albert and Bramley's Seedling, the results were on a par with those obtained in previous years.

(B) VARIATION IN CHARACTER OF THE FLUIDS USED.

So far, to keep the issue as simple as possible, this discussion has proceeded on the assumption that the washes used in 1930 were identical in quality with those of 1928 and 1929, but the following will show that some reservation on this point is necessary.

The circumstances of the production of washes made on the lines recommended by Long Ashton for use in the season 1929-30 need to be taken into account. Following the publication of the results of the Long Ashton trials for 1928-29, spray fluid manufacturers were faced at short notice with a large demand for a type of wash for which a specially prepared form of tar-distillate was required.

From the numerous enquiries received by the authors from many of them, it is evident that some difficulty was experienced in obtaining at that time the necessary quantities of a supply of tar-distillate conforming exactly with the specification. It is certain that variations in the quality of the tar-distillate used for these washes were by no means inconsiderable, and may well have been responsible for a part of the inconsistencies experienced. Further, it could hardly be expected that a new product, manufactured for the first time by several different makers, would prove absolutely uniform throughout.

Against this it may be urged that the results recorded above for the trials carried out by the authors with washes, mixed by themselves and prepared from a concentrated wash made under the personal supervision of Mr. Tutin, show similar variability. It has to be stated, however, that even in this instance the tar-distillate sample used does not stand entirely above suspicion on account of the following experiences.

In spite of the fact that, when the spray mixture was prepared, the tar-distillate used was free from deposit, it was found, at one centre in particular, when the time to apply the spray had arrived, that a very considerable amount of anthracene had been deposited by the mixture. This precipitated anthracene interfered with the formation of good emulsions, and it was found necessary to adjust very carefully the amount of alkali employed. It is conceivable that this trouble may have reduced the effectiveness of the wash. This deposition of anthracene from the sample of oil in question was due to inefficient cooling of the original tar-distillate fraction consequent upon the sudden and large demand for this product. It is only fair to state that the firm who supplied this product have now entirely overcome this trouble.

At another centre similar trouble was experienced, though to a lesser extent. This was finally overcome in a similar way. It is noteworthy that on trees sprayed with a mixture that had not emulsified well owing to the presence of precipitated anthracene, the results were definitely poorer than on those which had been sprayed with a good emulsion.

It will be seen, therefore, that there is evidence that, to some extent at any rate, variability of results noted during the past season may be ascribed to minor variations in the character of the fluids employed.

(C) VARIATION IN THE MIXING AND MODE OF APPLICATION OF THE WASHES.

A further undoubted cause of variability in the results obtained

by growers, both as regards pest control and injury to the buds, is that of errors in the mixing and application of washes on the part of some users or those employed by them. Enquiry has shown that, apart from such obvious and easily made slips as inefficient application with the attendant inevitable lack of coverage, certain other less frequent but nevertheless serious mistakes have occurred in individual cases. Errors in the method of mixing in the field have been traced. For example, failure to add the requisite amount of caustic soda solution has resulted in incomplete emulsification of oils, thus causing unemulsified oil to collect at the bottom of the tank; very serious injuries by bud damage to isolated trees scattered through the plantation naturally followed the application of such an uneven mixture.

One actual case of bud damage was due to the use of a "high neutral" wash and an "old-type" tar-distillate wash alternately, caustic soda being added to both. When the alkali was added to the "old-type" wash, oil was thrown out of emulsion and damage occurred.

Cases also were not infrequent where various brands of petroleum emulsion had been mixed with tar-distillate washes in the field. Such haphazard methods naturally led to much damage.

As far as could be ascertained, a proportion of the bud damage to apples in the Wisbech district was attributable to the use of two-solution washes with water which was not suitable for this purpose. Despite the fact that a general warning had been issued that washes of the two-solution type should only be used with the softer waters (such as "Marham" water), some growers, finding that an apparently correct emulsion was obtainable with certain dyke waters, used the latter. In many such instances damage resulted, but no cases of injury have been reported where "Marham" water was used. Unfortunately the proportion of growers able to utilise this water is comparatively small. On the whole, more bud damage seems to have resulted from the use of "one-solution" washes prepared from the "high neutral" tar-distillate than from the "two-solution" type.

Thus a percentage of the unsatisfactory results reported is unquestionably due to incorrect mixing or application of the wash by the user. Cases of bud damage in particular are frequently associated with these causes.

GENERAL CONCLUSIONS.

The foregoing consideration of possible causes of the varying results obtained with washes of the "high neutral" type, both in

the trials conducted by this Station and by individual growers, appears to justify three general conclusions : firstly, that the wash itself, properly made and applied, is undoubtedly intrinsically of the high order of Capsid egg-killing efficiency which the earlier trials had indicated, although its action in the field may be more influenced by weather conditions than could have been anticipated from the experiments carried out in the previous years ; secondly, that seasonal influences, acting on both pest and host plant, can cause relatively wide differences in the ultimate extent of Capsid attack on the crop (to a degree of which the two previous seasons' trials had not given the slightest indication), in spite of the trees being almost entirely freed from the pest at blossoming time ; and thirdly, that in the case of a newly introduced wash of this type an abnormal amount of variation in results in its first season of general use must be expected on account of the human factor.

The last named cause of variable results will adjust itself naturally experience is gained by both manufacturers and growers, but the second raises the very important points as to whether, in view of the seasonal factor, the necessary degree of Capsid control by an egg-killing wash can be secured with sufficient regularity for summer methods of control to be dispensed with and, if not, whether on economic grounds winter washing for control of this pest specifically can be afforded. The answers to these questions, forced into consideration by the experiences of 1930,—which may prove to be abnormal—can only be provided by observation extended over a sufficient period of years. Many points for investigation have been raised, some concerned with the killing properties of the washes in relation to weather conditions, others with the life histories and habits of Capsid bugs and others again with the behaviour of the different varieties of apples. Research on these matters is being proceeded with, and it would be premature to judge the capacity of these washes irrespective of weather conditions to control Capsid attacks without supplementary treatments until there is more knowledge available. For the time being it can be accepted that the 1930 results bear out those of earlier years, as to the relatively efficient Capsid egg-killing qualities of the wash, but create a doubt as to the adequacy of Capsid control by egg destruction alone under all types of weather conditions.

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THE CONTROL OF CAPSID BUGS ON BLACK CURRANTS.*

PROGRESS REPORT.

BY L. N. STANILAND, F. TUTIN AND C. L. WALTON.

During past years, the problem of control of Capsid Bugs on black currants has received considerable attention from various workers. In spite of their efforts, however, the injury caused by Capsid Bugs to black currants has, year by year, assumed more serious proportions, until many plantations have now become practically ruined. The damage in question is caused by two species of Capsid Bugs, namely, *Lygus pabulinus*, generally known as the Common Green Capsid Bug, and *Plesiocoris rugicollis*, the well-known Apple Capsid Bug. The former species is the more abundant on black currants, although in the West of England *P. rugicollis* is generally also present.

The respective life-histories of these species of Capsid Bug are well known, and have been described in a series of articles by F. R. Petherbridge and other workers.(1)

In general, the life-histories of the two species are somewhat similar. The eggs are laid embedded in the bark of the younger shoots of woody plants and pass the winter in this situation. Hatching commences in April, the young bugs appearing over a variable period. *P. rugicollis* has only one generation per year, but *L. pabulinus* has two, the second brood of eggs being laid in a great variety of succulent plants. In consequence, *L. pabulinus* increases at a greater rate than does *P. rugicollis*.

Both these species of Capsid Bug cause injury to the black currant by sucking, which, in the earlier stages, causes yellowish mottling and distortion of the foliage. Dead areas are subsequently produced and the leaves become riddled with holes. Later in the season, the effect of their activities is reflected in the type of growth produced by the bush. Owing to the damage caused to the terminal portion of the original shoots, a considerable proportion of lateral buds are forced into growth, practically all the later development of the bush taking the form of side-shoots.

* Reprinted from The Journal of the Ministry of Agriculture, August 1930, by kind permission of the Controller of H.M. Stationery Office.

Previous Methods of Control. Until recent years, control measures have taken the form of spring spraying with contact washes such as nicotine-soap mixtures. To obtain good results with such a wash, the application of a considerable amount of fluid by an experienced workman is necessary, and more than one spraying may be required.

With the advent of winter washes of the tar-distillate type, attempts were made to control Capsid Bug on black currants by their use, but without success.

Recently, however, it has been shown by two of the writers(2) that a tar-distillate wash, prepared from the high-boiling neutral fraction of a tar, is capable of effecting a measure of control of Capsids on black currants. Although this was not entirely satisfactory, it gave indications of promise. For instance, it was found that by using the improved type of tar-distillate wash in 10% concentration, a 70% attack could be reduced to one of only 20%.

It was very evident that endeavours should be made to improve still further the moderate measure of control which had been obtained by means of the winter wash, and with this object in view a new variant of tar-distillate wash was prepared and field trials have been conducted with it.

New Form of Wash Employed. It has already been pointed out by the writers(3) that a good control of Capsid Bug has been obtained by means of certain winter washes made from petroleum products, but that such washes failed to control Aphis and Psylla. It is well known, however, that control of the latter pests may readily be effected by means of a comparatively dilute concentration of a tar-distillate wash. From these and certain other considerations, it appeared probable that a winter wash of wider utility than those prepared from petroleum products, or from tar distillates alone, might be prepared by employing a mixture of these two liquids as a basis for the wash.

A mixture containing equal parts by volume of a high-boiling neutral tar oil and a heavy paraffin was, therefore, prepared. The neutral tar oil used was supplied by the South Metropolitan Gas Co., and was obtained from a horizontal retort tar. It contained only a trace of "tar acids" and had been deprived of excess of anthracene by cooling. It was collected during distillation between 280° and 360° C.

The heavy paraffin used was "Shell White Oil P.2."

Specific Gravity at 15° C.	..	..	..	..	0.865
Flash point (closed)	..	..	..	..	275° F.
" " (open)	..	..	..	..	305° F.
Viscosity, Redwood 1 at 70° F.	..	..	..	..	130 secs.
Iodine value (Wijs.)	..	..	..	..	1.1
Sulphur (calculated as such)	..	..	..	..	0.2 %

On distillation it commenced to boil at about 290° C., but only 26.4% by volume passed up to 360° C. It is therefore seen that the greater part of this heavy paraffin oil is even less volatile than the high-boiling neutral tar oil employed, a fact which would prolong the period during which a film of it would persist on the twigs and insect eggs after the trees had been sprayed.

For the purpose of emulsifying this mixture of "high neutral" tar oil and heavy paraffin, a procedure precisely similar to that described in the case of the "high neutral" tar oil wash was employed (*loc. cit.*, p. 133). Eighty-five parts by volume of the mixture of oils were thoroughly mixed with 15 parts by volume of Agral W.B., and, when emulsification was to be effected, 3 oz. of caustic soda were employed for every gallon of the concentrate. The emulsion obtained from this new mixture was even superior to that yielded by the plain tar oil wash.

This wash is referred to throughout the remainder of this article as the tar oil-heavy paraffin wash.

Field Trials, 1930. Field trials with the tar oil-heavy paraffin wash were conducted during the winter 1929-30 at two centres, using a 10% emulsion of the mixture described above. A plot was included at Centre I on which the ordinary two-solution, high-boiling, neutral tar-distillate wash, as used in the previous year's trials, was employed for purposes of comparison.

CENTRE I.—Newnham-on-Severn, Glos.

Variety : Baldwin.

The treatments carried out at this centre were as follows:—

- (1) High boiling, neutral tar-distillate wash (two-solution at 10% strength.
No. of bushes 32.
- (2) Tar oil-heavy paraffin wash (two-solution) at 10% strength. No. of bushes 94.
- (3) Tar oil-heavy paraffin wash (two-solution) at 12% strength. No. of bushes 36.
- (4) Controls, in two plots of 61 and 48 bushes respectively.
Total number of bushes in trial, 271.
Date of application of the sprays, February 5, 1930.

The sprays were applied by means of a sprayer of the "head-land" type, the weather at the time of spraying being favourable.

CENTRE II.—County Council Experiment Station, Perdiswell Worcester.

Varieties : Goliath, French, Baldwin, Seabrook's Black and Edina.

The varieties were in recurring series of rows and all of them occurred within the sprayed and unsprayed plots.

The treatments carried out at this centre were as follows :—

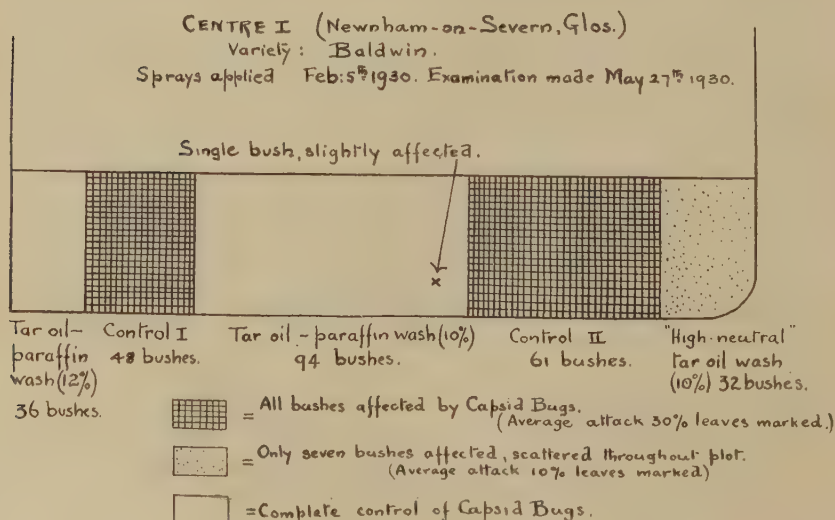
- (1) Tar oil-heavy paraffin wash (two-solution) at 10% strength. No. of bushes 42.
- (2) Control plot. No. of bushes, 44.
Total number of bushes, 86.
Date of application of the sprays, February 6, 1930.

The spray was applied at this centre also by means of a "headland" sprayer, during fine, dry weather.

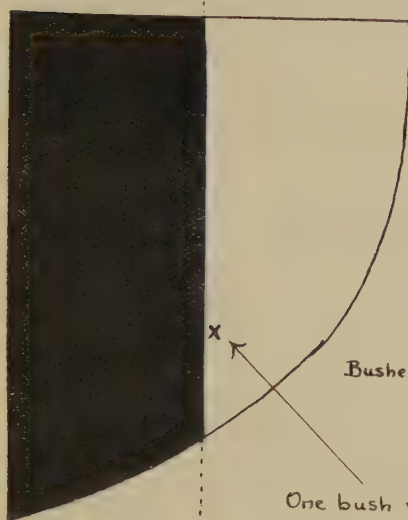
Lygus pabulinus and *Plesiocoris rugicollis* were present at each centre, though the former species predominated. No other pest was present in appreciable numbers.

Results. The results obtained by examinations on May 27 and 28 are shown in Diagrams I and II, together with the layout of the plots.

It will be seen from the diagrams of the plots on which the experiment was conducted that a practically complete control of Capsid Bugs on black currants has been effected by the use of the tar oil-heavy paraffin winter wash at 10% strength. The results obtained by means of the high-boiling neutral tar-distillate wash are comparable with those obtained during the field trials of 1928-29.



CENTRE II. (Pendiswell, Worcs.)

Control.
44 bushes.Tar oil paraffin
wash (10%) 42 bushes.

Varieties:

Goliath.

French.

Baldwin.

Seabrook's Black.

Edina.

(In recurring lines
across both plots).

Bushes large and frequently touching.

One bush with 3 leaves affected.

Nearly all bushes badly affected by Capsid Bugs.
(Average attack 60% of leaves marked)

Complete control of Capsid Bugs.

Sprays applied Feb: 6th 1930. Examination made May 28th 1930

The bushes at Centre II were very large and all varieties were heavily infested. At the time of examination a number of bushes on the control plot showed over 80% of leaves injured by Capsid Bugs, a large proportion for so relatively early a date. Notwithstanding the heavy infection of this plot with Capsid Bugs, it will again be seen that a practically complete control of these pests has been effected.

At neither centre could any evidence of spray damage be detected.

SUMMARY.

The preparation of a winter wash from a mixture of high boiling, neutral tar oil and a heavy paraffin oil is described.

This new wash emulsifies very well and gives an excellent "spread" and "cover" on the trees. When used in 10% concentration on black currant plantations it has effected a practically complete control of Capsid Bugs.

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THE RASPBERRY AND LOGANBERRY BEETLE AND ITS CONTROL.*

FURTHER EXPERIMENTS WITH PYRETHRUM EMULSION SPRAYS AND A DUST.

BY C. L. WALTON.

INTRODUCTION.

The result of experiments on the control of the Raspberry and Loganberry Beetle carried out during 1928 and 1929 appeared in the *Journal of Pomology and Horticultural Science* for May, 1930 (1). It was there shown that a "commercial" control of *Byturus tomentosus* could be obtained by three successive applications of a pyrethrum emulsion spray when approximately one-third, two-thirds, and all the flowers were fully open. This spray has the advantage of being non-poisonous, and is harmless to flowers and foliage. Recent experiments indicate that the honey bee is apparently not affected by Pyrethrum vapours (2).

Satisfactory as these results were, it was nevertheless resolved to carry out a further series of field trials during 1930 for the following reasons. The trials of 1928 were of a purely initial character, and since in the more extensive series of 1929, the principal one was on Raspberries, it was felt that a more extensive trial should be conducted on Loganberries. Furthermore, it afforded an opportunity for the trial of Pyrethrum in more varied forms.

FIELD TRIALS IN 1930.

These trials included the following: (1) An emulsion spray precisely similar to that used in the previous trials and made up according to the formula published by Tutin (3) and (4). This spray when needed for use in the field requires the addition of caustic alkali and is hence of the "two solution" type. This is referred to in the Diagram and Table A as Spray I. (2) A spray made up from a concentrated extract and prepared in such a way that it emulsified on being mixed with water, thus obviating the somewhat troublesome business of adding caustic alkali in the field. This spray is described as Spray II in the Diagram and Table A. (3) A dust in which the active principles of the Pyrethrum flowers were incorporated with a carrier. This dust is of such a strength that ten parts represent the active principles of one part of Pyrethrum flowers.

*Reprinted from "Journal of Pomology and Horticultural Science," Vol. VIII, No. 4, December, 1930.

The trial centres utilized were three, namely, one in Herefordshire for the main trial on Loganberries, in which all the forms of *Pyrethrum* enumerated were included, and where both the sprays and the dust were applied three times; and two at Long Ashton, for subsidiary trials, one on Loganberries and one on Raspberries. In both these latter only the dust was employed, the reason for its use being that it was of considerable commercial importance to discover whether it would be as effective as the wet spray, owing to the comparative ease with which it can be applied as compared with the latter.

Trial I. Breinton Manor, Hereford.

Layout of Trial.—The trials here were on Logans. The lay out is shown in the accompanying diagram and the results are in Table A.

Reference to the diagram will show that the rows of Logans adjoining an apple plantation were selected for trial. This was done because experience has shown that infestation is usually most severe in the vicinity of apple, pear, hawthorn, etc., and this proved to be the case. The first six rows were treated with the exception of a central untreated block left as a control. In order to obviate any effects on results from drifting dust or spray, the next six rows were left to act as a "buffer" and not taken into account. Finally the remaining spray was applied to a part of each of the following six rows, the unsprayed portion of which served as a separate control.

Sprays and dust were applied in suitable weather to all plots on June 5th, 12th and 19th-20th, when approximately one-third, two-thirds and the whole of the flowers respectively were fully open. The sprays were applied by means of a power sprayer and four spray guns, working at a pressure of 100 to 150 lbs., and the dust by means of efficient "knapsack" dusters.

The dates of the counts are given in Table A. The total number of fruits examined was 17,000. All counts were "random samples" and all the fruits were examined on the spot.

Observations on Results.

Sprays.—It will be seen that both the sprays employed gave satisfactory results. It will further be noted that there was a very marked difference in the degree of infestation between rows 1-6 (next to the apple trees) and rows 12-17, the average infestation on the former being over 30 per cent. whilst on the latter it was barely 10 per cent.

Dust.—This gave results of a much inferior character, as compared with the sprays. Furthermore, the carrier employed adhered very firmly to both fruits and foliage and, in spite of subsequent heavy rain, rendered the former unsightly for the greater part of the picking period.

TABLE A.
Loganberries—Breinton Manor, Hereford.

Date of Picking	July 14.	July 16.	July 18.	July 21.	July 25.	July 28.	Aug. 1.	Aug. 6.	Aug. 11.	
No. of Fruits examined per Plot	500	300	300	400	400	400	400	400	300	Totals per Plot. 3,400
Percentage Infestation Control A.	59.4	55.0	54.0	45.5	34.5	23.3	17.0	10.7	6.7	Average Infestation. 35.8
Dust	34.8	31.3	30.7	35.5	27.5	24.5	12.0	6.7	5.2	23.1
Spray II (One Solution)	5.0	9.3	7.3	9.5	6.0	8.3	7.5	6.7	7.5	7.4
Control B.	13.8	11.3	11.3	14.6	9.7	10.2	6.7	5.6	3.7	9.6
Spray I (Two Solution)	1.0	.3	.3	—	.7	1.0	2.0	1.5	2.5	1.03

Trial II.—Gardens at Long Ashton.

Lay-out of Trials.—This trial was carried out in two heavily infested private gardens, situated near one another in the village of Long Ashton. The dust only was used. Each trial was conducted on a short row of Logans, a portion of which was sprayed and the remainder left unsprayed as a control. The relatively short picking period (as compared with the commercial plantations at Hereford) is accounted for largely by the very dry conditions which had prevailed, and it may be noted also that picking commenced a fortnight earlier than at Hereford. The dust was applied by means of a small hand machine on June 1st, 4th and 6th for Garden I; and on the 2nd, 10th and 16th for Garden II. The total number of fruits examined was 1,883 for Garden I and 3,419 for Garden II—total 5,302. The results are set out in Table B.

TABLE B.
Pyrethrum Dust—Loganberry Fruit Counts.
Gardens in Long Ashton.

Date of Picking.	Percentage Infestation.	
	Control.	Dusted.
<i>Garden I. :</i>		
4/7/30	86.0	53.3
7/7/30	86.4	57.4
11/7/30	83.0	71.6
15/7/30	89.4	84.3
Average	86.2	66.6
<i>Garden II. :</i>		
7/7/30	59.2	31.3
10/7/30	60.2	37.1
15/7/30	62.5	46.2
18/7/30	68.3	59.2
Average	62.5	43.4

Observations on Results.

It will be seen that the average reduction of infestation was only about 20 per cent., and that in spite of the three applications, the infestations remained comparatively high. Here also the same unsightly effect of the dust previously mentioned was apparent.

Trial III.—Long Ashton Research Station.

Lay-out of Trial.—This trial was designed to determine (a) the effect of the dust on raspberries as compared with logans, (b) the effects of a single application and (c), by the inclusion of three

varieties (Lloyd George, Baumforth A and Duke of Cornwall) whether the different varietal forms of flower would have any effect on the result. In Duke of Cornwall the flower is of a more open type; this, it was expected, would result in the lower infestation after treatment, since (1) less shelter is afforded to egg-laying beetles and (2) the dust could reach the beetles with greater ease.

The dust was applied on June 2nd and 3rd, by means of knapsack dusters.

The total number of fruits subsequently counted was 4,565.

TABLE C.
Pyrethrum Dust—Raspberry Fruit Counts.
Long Ashton Experimental Station Variety Trials.

Variety.	Date of Picking.	Percentage Infestation.		Difference in Infestation.	Percentage Reduction in Infestation.
		Control.	Dusted.		
Lloyd George ..	1/7/30	32.5	19.5	13.0	40.0
	4/7/30	42.2	22.9	19.3	45.7
	7/7/30	28.9	16.8	12.1	41.9
	9/7/30	23.0	21.5	1.5	6.5
Average ..		31.6	20.1	11.4	33.5
Baumforth A. ..	4/7/30	33.6	23.1	10.5	31.2
	7/7/30	31.0	16.1	14.9	48.1
	9/7/30	20.5	21.0	—	—
Average ..		28.3	20.0	8.4	39.6
Duke of Cornwall	4/7/30	27.9	10.3	17.6	63.9
	7/7/30	22.3	12.7	9.6	43.1
	9/7/30	14.5	8.0	6.5	44.8
Average ..		21.9	10.3	11.2	50.6

Observations on Results.

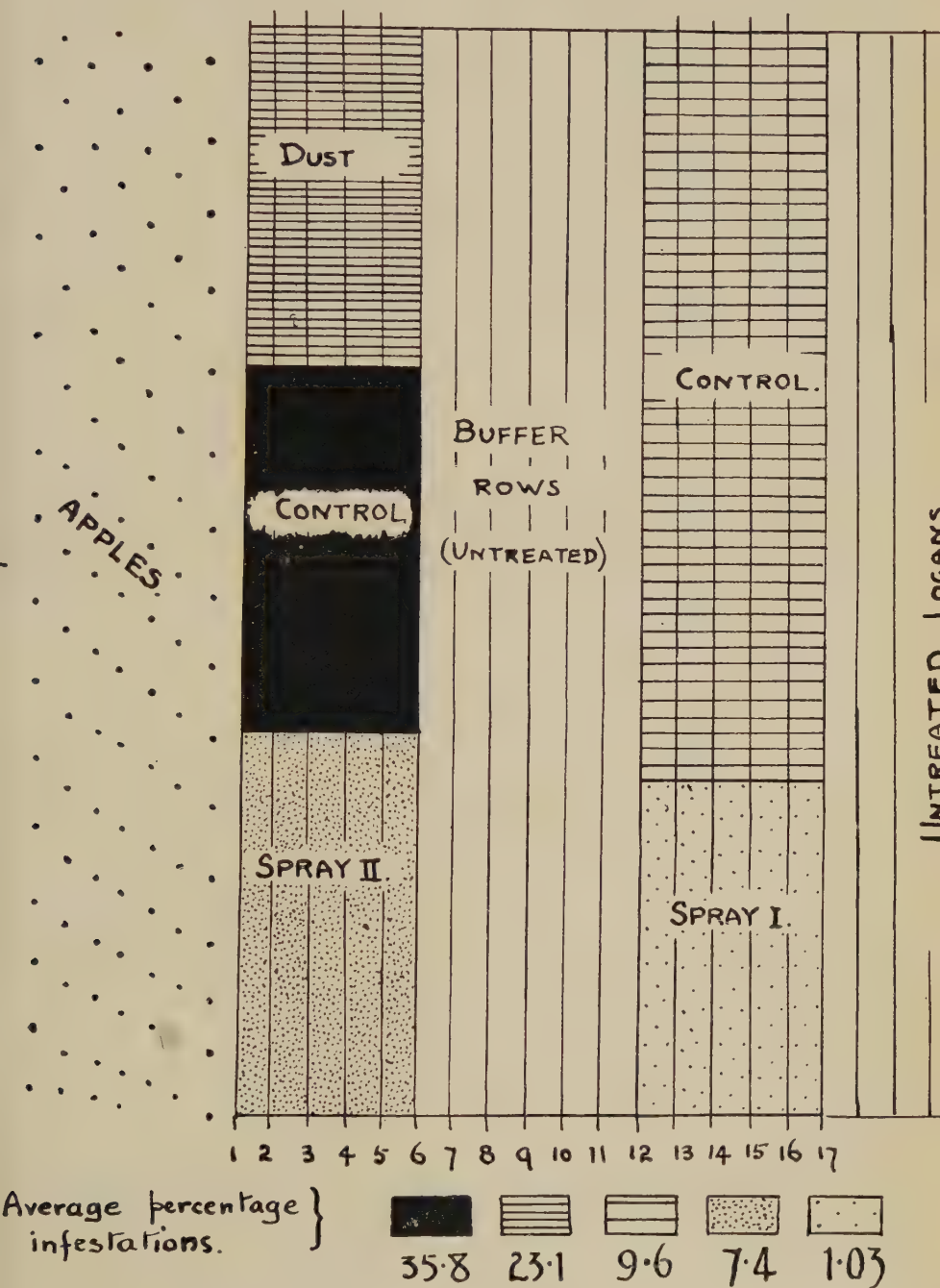
Here again the reduction of infestation, although somewhat higher than in the case of the Logans, was much inferior to that obtained by means of the spray. The expectation that infestation would be lower in Duke of Cornwall was to some extent borne out, whilst the reduction of infestation was also slightly greater.

GENERAL REVIEW AND CONCLUSIONS.

The results detailed show that both sprays gave excellent results, thus bearing out the figures of the two previous years.

On Logans, average infestations of 35.8 per cent. and 9.6 per cent.,

Untreated Logans



were reduced to 7.4 per cent. and 1.0 per cent. respectively. It is notable also that this was during a period extending from July 14th to August 11th, covering almost the entire cropping period.

In view of these results it is felt that these sprays are worthy of extended trials by growers since the figures obtained indicate that infested areas so treated should be sufficiently freed from the pest for the crops to be suitable for canning and bottling operations. These Pyrethrum Emulsion sprays moreover possess the advantage of being non-poisonous, do not scorch foliage, or impart any adverse colour or flavour to the fruit.

The results given by the dusts were in no way equal to those obtained with the sprays, and the carrier employed adhered to the fruit, giving it a grey appearance.

ACKNOWLEDGMENTS.

Thanks are due to the British Dyestuffs Corporation Ltd. for supplying the materials necessary for the two solution mixture (Spray I), and also to Messrs. Stafford Allen & Sons for preparing the concentrated extract which emulsified directly with water (Spray II) and also for the Dust.

Acknowledgment must again be made to Mr. G. Marshall, Breinton, Hereford, and his sons, for the large amount of trouble taken in connection with the main Loganberry trial, also similarly to Prof. B. T. P. Barker and Mr. G. T. Spinks in connection with the smaller trials.

Finally, I must thank Mr. Edward McC. Callan for the great assistance he gave in collecting the data set out in the Tables.

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A NOTE ON THE CONTROL OF WOOLLY APHIS ON DORMANT NURSERY STOCK.

BY L. N. STANILAND AND C. L. WALTON.

At the suggestion of the Ministry of Agriculture, arrangements were made during the winter of 1928-29 to test various methods of treatment of young dormant fruit trees, after removal from their nursery quarters, for the destruction of adherent insect pests.

A batch of young apple trees heavily infested with Woolly Aphis (*Eriosoma lanigera*) was secured and treated as described below.

The results obtained were not reported in the last Annual Report, since it was hoped to amplify the work and include experiments with other pests also. So much difficulty in securing suitable further material has been experienced that it has been decided to publish without further delay such results as have been obtained already.

The material available for the 1928-29 experiments consisted of 48 bush and 48 standard apples. These were divided into six lots of sixteen trees each, eight bush and eight standards in each lot. Each lot of sixteen was subjected to a different treatment. A record of the treatments, with the results in each case, is given in the appended Table.

As regards individual treatments, dipping consisted in immersing in a tank containing the wash the entire trees, roots included, for a sufficiently long period to ensure thorough wetting.

Trees treated by spraying were placed against a wall and the spray applied by means of a bucket pump until they were thoroughly wetted ; the trees were then reversed and the process repeated.

After treatment all trees were allowed to drain and dry previous to planting.

In the case of the fumigated trees, fumigation was carried out in a gas-proof chamber.

Subsequent to the treatments the trees were planted together on a plot of cultivated land and kept under observation until early June in the following year.

After periodical preliminary observations on the effects of the treatments, final examination of the condition of the trees was made on June 7th, 1929.

TREATMENTS AND RESULTS.

Treatment (26.11.28):	No. of Trees.	Results of Observations (7.6.29).		
		Trees Infested with Woolly Aphis.	Trees free from Woolly Aphis.	Trees Dead.
Hydrocyanic Acid Gas. (1 oz. sodium cyanide per 100 cu. ft. for 1 hour) ..	16	13	2	1
10% Tar Oil Wash* (Dipped) ..	16	—	16	—
10% Tar Oil Wash (Sprayed) ..	16	—	16	—
Nicotine and Soft Soap Spray (8 oz. per 100 gallons). (Dipped) ..	16	6	10	—
Nicotine and Soft Soap Spray (Sprayed)	16	6	10	—
Controls	16	10	6	—

* The tar oil wash was one of the old type in common use prior to the introduction of the more modern neutral high-boiling type.

It would appear from this small experiment that infestations of Woolly Aphis on young apple trees may be eradicated by immersion for a few minutes in a 10% solution of Tar Oil wash or by spraying thoroughly with the same material. The 32 infested trees so treated all remained free up till 7th of June in the following summer. This method would seem to offer an easy and inexpensive method of cleansing infested nursery stocks, without injury to the trees themselves.

Fumigation with hydrocyanic acid gas proved almost a complete failure, whilst treatment with a nicotine and soft soap solution was only partially successful.

THE CONTROL OF GALERUCELLA LINEOLA— A MAJOR PEST OF WILLOWS.

By

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The Chrysomelid beetle—*Galerucella lineola*—causes extensive damage to the basket willow crops of Somerset and of other districts where varieties susceptible to attack are grown. Of the insecticides used by growers for its control, nicotine is most favoured but the results following its use have not been fully satisfactory in that partial control only has been effected with much expense in labour and material. With a view to the discovery of a more efficient means of control the observations and investigations recorded in this paper have been made.

The problem was investigated in the following sequential stages:—

- (a) Study of the life history and habits of the beetle with a view to ascertaining those times at which methods of treatment might be most advantageously applied.
- (b) The action of insecticidal preparations by laboratory tests.
- (c) Field trials based on laboratory results.

Outline of Life History and Habits.

The beetles hibernate in such places as dead trees, gate posts and heaps of vegetable waste. As attacks on a willow bed recur annually, it is highly probable that hibernation takes place in its vicinity, although the beetles possess considerable powers of flight. This view is supported by the fact that seasonal attacks commence near old willow trees growing on field boundaries.

The beetles are able to survive prolonged wet conditions, for

there is no decrease in intensity of their attacks in a season following heavy floods. It has, indeed, been observed that flood water acts as a distributing agent, the debris deposited on the beds becoming centres from which spring attacks arise.

Two-year-old rods are the first to be attacked because the buds unfold earlier than the basal buds of plants, the rods of which have been removed during the previous cutting season. After a period of feeding, egg laying commences about the beginning of June. The eggs are deposited in batches on the upper leaves of the rod and are conspicuous. The larvae are found in considerable numbers during the last weeks in June. Pupation takes place in the soil. Emergence of the second brood of beetles commences during the first week in August. Egg laying, development of larvae and pupation stages are succeeded by a second brood of adults which appear in September. These beetles ultimately go to hibernation at the period of leaf fall.

The beetles and larvae feed on the terminal portions of the rod, attacking stem, buds and leaves. Frequently the bark of the stem is so severely damaged as to kill the terminal portion of the rod. The adult eats the leaf as a whole, leaving the midrib; the larva skeletonises the leaf by eating the epidermis and mesophyll. In severe attacks complete defoliation may occur. The damage results in the formation of side shoots and loss in yield.

CONTROL EXPERIMENTS AND TRIALS.

Laboratory Experiments.

Attempts to control the pest by killing eggs and adults with the preparations Pyrethrum emulsion, nicotine, paraffin emulsion and lead arsenate not having proved successful, the action of these insecticides on the larvae was more fully investigated.

Shoots on which larvae were feeding were dipped on June 26th, 1930, in these preparations and the larvae kept subsequently under observation. The following results (Table I) were noted :—

TABLE I. EFFECT OF VARIOUS INSECTICIDES ON LARVAE.

Insecticides.	Strength.	No. of Larvae treated.	Dates of Examination.											
			27/6/30			28/6/30			29/6/30			30/6/30		
			A	?	D	A	?	D	A	?	D	A	?	D
Pyrethrum Emulsion ..	2 galls. extract and 100 galls. water	75	40	35	0	0	20	55	0	3	72	0	0	75
Nicotine ..	$\frac{3}{4}$ oz. nicotine 1lb. soft soap 10 galls. water	41	11	30	0	10	0	31	0	7	34	0	0	41
Soft Soap ..	3lbs. to 10 galls. water	24	24	0	0	24	0	0	24	0	0	21	0	3
Paraffin Emulsion ..	1 gall. paraffin 2 galls. soap 100 galls. water	27	5	22	0	1	22	4	0	1	26	0	0	27
Agral 1 ..	2½ lbs. Agral 100 galls. water	24	24	0	0	24	0	0	24	0	0	22	2	0
Control ..	— — —	24	24	0	0	24	0	0	24	0	0	20	2	2

A = Active Larvae. ? = Doubtfully alive. D = Dead Larvae.

TABLE II. FIELD TRIALS WITH INSECTICIDES ON LARVAE. PLOT PLAN.

Treatment.	Nicotine.	Control.	Pyrethrum.	Control.	Paraffin.	Control.	Lead Arsenate.	Control.	Pyrethrum Dust.
Percentage of Attacked Rods	3	15	6	39	29	64	3	40	8

By a similar method shoots on which 30 larvae were feeding were sprayed with lead arsenate of strength 1lb. to 18 galls. water. Death of all the larvae occurred within 7 days.

It was conclusive from these tests that the insecticides, Pyrethrum emulsion, nicotine, paraffin emulsion and lead arsenate, were in each case sufficiently toxic to larvae to warrant their application on a larger scale.

Field Trials.

Plots, each $1/32$ acre in size with controls intervening, were taken on a commercial bed of the Black Maul variety and treated with the insecticides, etc., on June 26th.

Conditions were favourable: the weather was fine and dry, and the majority of the eggs had hatched. The sprays were applied at the rate of 350 gallons to the acre by knapsack, care being taken to effect a complete wetting of all leaves.

The Pyrethrum emulsion, lead arsenate and nicotine gave even spreads, but the paraffin emulsion was less satisfactory in this respect owing to the unsuitability of the soap used for the water of the district.

Results—Effects on Larvae.

The larvae responded immediately to all the insecticides applied with the exception of the paraffin emulsion. The contact insecticides caused body contortions followed by a fall to the ground and death. A number of larvae from the nicotine and Pyrethrum plots were kept under close observation for three days. Few recoveries took place in these cases. The effects of the insecticides were further noted by assessing crop damage, the following method being used.

On July 22nd—27 days after spraying—three rows of willows were selected at random from each bed. From these rows 100 rods on neighbouring plants were examined in consecutive order. The number of rods attacked by, and free from, larval damage was as shown in Table II appended.

The results show clearly without further comment that, with the exception of the paraffin emulsion, the insecticides as used effected satisfactory control.

CONCLUSIONS.

The beetle—*Galerucella lineola*—can be most effectively controlled by spraying with any of the preparations:—

Pyrethrum emulsion, 2 gallons with 100 gallons water.

Nicotine $\frac{3}{4}$ oz. with 10 gallons water and 1lb. soft soap.

Lead arsenate .. 1lb. with 18 gallons water and an efficient spreader.

Applications should be given when the beetles are in the first larval stage, viz., about the third week in June.

Thorough spraying of the crop is essential, special care being taken to ensure complete wetting of the upper portions of the rods.

THE CONTROL OF PHYLLODECTA VITELLINAE L.
(CHRYSOMELIDAE.)
A MAJOR PEST OF WILLOWS.

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This beetle is the most serious insect pest of certain species of basket willows. At times, its depredations are very extensive and may result in the total loss of crop.

The pest is to be found, as would be expected, in the districts where those species of willows susceptible to attack are cultivated; particularly in Lancashire, Leicestershire, Berkshire and Gloucestershire, where the rods produced, particularly those of the species *Salix purpurea*, are of superior quality on account of their suitability for the making of special basket ware.

Life History of the Beetle.

The life history has been closely investigated on the willow variety beds at the Research Station, Long Ashton, and in order to ascertain the influence of different environments, the data obtained there have been compared as far as possible with observations made on the beetles in other localities.

The beetles hibernate, closely packed together, in various sheltered quarters such as is provided by the loose bark on trees, the cracks in willow stumps, the bark on palings, piles of dry vegetable rubbish, the slates and tiles of houses, outhouses, etc.

Migration from winter synchronises with bud burst. It is gradual from April until the end of May, so that the total surviving winter population is in full attack at the beginning of June. In the case of late emergence, the beetles confine their attention almost entirely to the leaves on the terminal portion of the rod in preference to the older leaves. Uncut rods are the first to be attacked because,

in this case, the buds commence growth at an earlier date than those on heads which have been cut in the previous season.

After a period of feeding, mating takes place and egg-laying commences. The oviposition period extends from about the last week in May until the third week in June. It is during these three weeks that the majority of the eggs are laid. A large number of eggs may be laid at the end of May, but in some seasons, owing to a change in the climatic conditions, the remainder may not be laid until the second or third week in June. Thus in 1930, many eggs were laid about May 27th, and a second oviposition occurred about mid-June. This delayed oviposition is of considerable importance from the point of view of control measures, and is discussed later in this article (see *Pyrethrum emulsion*).

The eggs are laid on the undersurfaces of the lower leaves of the rod. They are deposited in batches of 10-30, and the total number laid by one female is approximately 200-300, but under certain circumstances as many as 400 may be laid. The eggs, which are glabrous, white in colour and 0.8 mm. long x 0.28 mm. diameter, hatch in 7-14 days—the majority in 13 days.

There are three larval instars (stages) and in general appearance, but not in size, each resembles the other. The larva is of typical Chrysomelid shape and, although it can be quite active, it does not move very much when food is plentiful. Under normal feeding conditions the larvae hatching from the same batch of eggs, feed, as it were, "shoulder to shoulder" until they are full grown, and progressively strip leaf after leaf.

The larvae possess dorsal protrusible glands. The first instar possess only two pairs of functional glands which are situated on the thorax; these produce very little glandular fluid. In the early second instar, although the full number of 9 pairs of glands is developed, the secretion is scanty. In the late second and third instar, a copious flow of glandular fluid is produced on the eversion of the glands. This glandular product will be referred to in more detail in the paragraph dealing with *Pyrethrum emulsion* and dust.

The larval period extends from 15-23 days, the variation being due to a number of factors, including variations in climatic conditions, cell sap of the host plant, etc. The full grown larva is approximately 4.5 mm. long x 1.25 mm. diameter, and goes to earth to pupate just below the surface of the soil. The pupal instar lasts for approximately two weeks, and the day after emergence, the beetle climbs up the willow rod and commences to feed.

A second brood of beetles begins to emerge during the first week in August, and the numbers increase until the end of the third week in this month. It is at this date that the greatest amount of adult damage occurs, due to the great increase in the number of beetles present. In August, 1930, the number of beetles on some beds were so numerous that the upper foliage was completely stripped, and this damage, combined with the earlier larval damage, left the rods bare. In other cases, where foliage was plentiful, the adults caused such extensive defoliation that the larvae emerging from their eggs laid on the lower leaves did not attain complete development owing to lack of food. In this case, all larvae not three-quarters grown (*i.e.* not third instar), died of starvation.

The beetles of the August brood soon commence egg-laying, and the life-cycle resembles that of the first brood, in form and length of time occupied. Emergence occurs during the first week in October. This brood of beetles feeds until leaf-fall, when the adults migrate to hibernation quarters, complete migration frequently taking place in one day.

The beetles have not been observed flying, although well developed hind wings are present, and their mode of attacking a willow bed, namely, by commencing at the outskirts and gradually invading towards the centre of the bed, indicates that walking is their principal means of progress.

Nature of Damage.

The injuries inflicted on the host plants may be conveniently divided into two groups :—

- (a) Damage caused by adults.
- (b) Damage caused by larvae.

(a) *Adult Damage.* It has been mentioned that the adults may appear from hibernation quarters in spring, before the foliage buds of the willow have opened. In retarded seasons, the unopened buds on the stools are eaten, leading at times to the death of heads, and always to loss of the largest rods due to the excessive basal branching.

The beetles have a marked preference for feeding on the terminal portion of the rod. Injury to the growing point results in branching, whereby the whole plant becomes bushy in habit, and consequently of little value from the basket-maker's point of view.

The beetles feed on the upper epidermis and mesophyll of the leaf, and at times they cluster in dozens on one leaf, especially on the larger leaved varieties such as Lumley.

The damage is similar in the case of each brood, but the extent varies according to the number of beetles and the species of willow. Up to 14 inches or more of the foliage on the terminal portion of the rod is frequently completely stripped.

(b) *Larval Damage*. Soon after hatching from the egg the larvae commence to feed. Each larva consumes from $2\frac{1}{4}$ -4 sq. cms. of foliage during its larval life. Thus, an average batch of 22 larvae will consume approximately 49-88 sq. cms. of foliage, which is equal to about 12-22 leaves of such a variety as Brittany Green. The larvae feed only on the lower epidermis and mesophyll of the leaf. They move from the lower to the higher leaves, stripping them in consecutive order. Each leaf is completely skeletonised. The larvae are so numerous at times that the whole bed may be defoliated. Attacked leaves soon fall.

Susceptibility of Willow Varieties to Attack.

The varieties of willows exhibit great differences in the degree of susceptibility to beetle attack. The data given below summarise observations made under field conditions.

In order to indicate the varying degrees to which varieties are attacked, the host plants are divided into three groups :—

- (a) Severely attacked.
- (b) Attacked.
- (c) Not attacked.

(a) Severely attacked.	<i>Salix purpurea</i> .	All varieties, e.g., Brittany Green, Green Dicks, Leicester Dicks, Goldstone.
	<i>Salix alba vitellinae</i> .	Golden Willow.
	<i>Salix alba</i> .	White Willow.
	<i>Salix nigricans</i> .	
	<i>Salix repens</i> .	Ornamental Creeping Willow.
(b) Attacked.	<i>Salix</i> ?	Lumley, Patent Lumley.
	<i>Salix hybrids</i> .	e.g., Mawdsley, Harrison, Red
	(<i>purpurea</i> x <i>viminalis</i>).	Root.
(c) Not attacked.	<i>Salix fragilis</i> .	Crack Willow.
	<i>Salix viminalis</i> .	Only very slightly attacked by the beetles and not by the larvae, e.g., Mealy Top, Longskin, Clay Rods.
	<i>Salix coerulea</i> .	Cricketer Bat Willow.
	<i>Salix triandra</i> .	e.g., Black Maul, Champion, Glibskin, Stone Rod.
	<i>Salix americana</i> .	Salicians.

Where different varieties are grown in close proximity to one another, the question of the beetles selecting certain host plants in

preference to others arises. Thus a species grown under the above-mentioned conditions might only be slightly attacked yet if grown apart from another species more liable to attack would perhaps be severely attacked.

The beetles and their larvae have been found on poplars.

Methods of Control.

No natural enemies have been observed.

No Hymenopterous or Dipterous parasites were bred out during the progress of the experimental work, and the late Dr. James Waterston, British Museum (Natural History), had no records of Hymenopterous parasites.

Previous Use of Insecticides. Difficulty has been experienced in this country, as well as on the Continent, in controlling this pest. It appears that the principal reasons for the failures that have occurred have been the haphazard methods and inappropriate times of application of various insecticides, without due consideration of the life cycle and the anatomy of the larva and adult. Reviewing the meagre literature on this, and allied willow pests, and also the various recommendations given in the past as possible methods of control, it appears that nicotine and paraffin in various forms have given partial control, and that lead arsenate has not given satisfactory results. Owing to the absence of critical data, it was decided to investigate possible methods of control. The insecticides selected for experimental work were Long Ashton Pyrethrum emulsion, Pyrethrum dust, and lead arsenate.

Reviewing the life history of the beetle, it appeared that, since it is present on the host plant as egg, larva, and adult, an investigation of the action of the above insecticides was necessary on each instar.

Experiments with a Pyrethrum Emulsion Wash. The Pyrethrum emulsion employed in the experiments was of the two-solution type, and was prepared according to Tutin's* formula. It was used at the strength of 2 gallons of Pyrethrum extract plus rape oil and emulsifier, to 98 gallons of water, representing approximately a concentration of 1% of the original flowers.

Both laboratory and field tests were carried out and the toxicity of the wash to the eggs, larvae and adults was ascertained.

(a) Laboratory Experiments.

Toxic Effect on the Eggs. The emulsion will not kill the eggs and

* 1928 and 1929 Annual Report, Long Ashton Research Station.

the number of days it will remain toxic after application has yet to be determined critically. Larvae hatching from the eggs the day after application died, but three days after application the toxicity was so reduced that the eggs hatched, and the larvae fed on the foliage and suffered no apparent harm.

Toxic Effect on the Adults. Provided that the beetles are well wetted with the emulsion a 100% kill is obtained, but this result cannot be obtained under field conditions owing to the density of the foliage. The following field experiment demonstrates the difficulty.

The emulsion was applied to a bed of Brittany Green on May 27th—a sunny day which induced the beetles to feed in exposed positions—at the rate of 300 gallons per acre. A knapsack sprayer was used. A large number of beetles fell to the ground before the full force of the spray reached them. Many were untouched by the spray, whilst those partially wetted became dried by contact with the soil. A number were collected and kept under observation. Of these, 82% recovered and re-commenced feeding on fresh foliage the following day.

It follows from the above example that one application of Pyrethrum emulsion is of little value as a means of controlling the adults. Repeated applications would be necessary at intervals of a few days to ensure any measure of success. This would require much labour and material, should the rods be more than about 8 inches long.

In the event of the beetles attacking the buds that are commencing to open on the head of the willow stump, probably repeated applications of the emulsion might prove of some value, owing to the absence of foliage, and the fact that the beetles are concentrated on the stools.

Toxic Effect on the Larvae. Owing to the fact that the larvae feed on the lower surface of the leaves, it would appear that they would be comparatively easy to kill with a contact insecticide. This, however, is not the case in practice, although the upper and lower epidermis of the leaves of all varieties of willows are capable of being evenly wetted by the emulsion.

Small field experiments gave very variable results, ranging from almost complete control to hardly any control at all; in all cases particular care was taken to spray thoroughly the lower surfaces of the leaves on which the larvae were feeding. The variable results obtained in these preliminary tests demanded further enquiry, and consequently the problem was investigated more fully.

A number of rods of a *Salix purpurea*, infested with larvae were taken into the laboratory and dipped into freshly prepared Pyrethrum emulsion for five seconds. The excess of emulsion was allowed to drain off and the few larvae that had left the foliage whilst in the dipping tank were discarded. The rods were then struck into damp sand and the reactions of the larvae were observed and classified into three groups as follows :—

- (1) Larvae that walked off the foliage and down the rod within five minutes of dipping.
- (2) Larvae that walked off the rod 30 minutes after dipping.
- (3) Larvae that remained on the foliage.

Observations were made over a period of five days. The larvae in Group (1) were provided with freshly sprayed but dry foliage three days after the commencement of the experiment. Controls were provided, one batch of larvae with fresh foliage being supplied daily as a control to Group (3), and one batch of larvae without food as a control to Groups (1) and (2).

The results are shown in the following table where observations on the condition of the larvae are expressed as dead, doubtful whether alive, and alive.

TABLE I.

PYRETHRUM EMULSION.

The Toxic Effect on the Larvae of *Phyllodecta vittellinae*. Experiment commenced 4 p.m., 26.6.30.

Date of Examination.		10 a.m. June 27th.	10 a.m. June 28th.	10 a.m. June 29th.	June 30th.	July 3rd.
Condition of Larvae.		A. ? D.	A. ? D.	A. ? D.	A. ? D.	A. ? D.
Dipped Larvae.	Group (1)	..	89 51 0	89 51 0	62 11 67	—
	Group (2)	..	44 6 0	44 0 6	39 0 11	—
	Group (3)	..	26 111 0	14 111 12	9 0 128	—
Control for Groups (1) and (2). No foliage.	1st instar larvae	..	40	—	—	40 0 0
	2nd instar larvae	..	80	—	—	0 16 72
	3rd instar larvae	..	18	—	—	— 18
Control for Group (3). Fresh foliage daily.	—	—	120 0 0	120 0 0	105 0 0	—
	—	—	—	—	15 pupae	—

A = Alive. ? = Doubtful whether alive. D = Dead.

For definition of Groups (1), (2) and (3) see text.

The larvae classified as alive were found to be in the late second or third instar, whilst those larvae classified as doubtful, and eventually proven to be dead, were larvae of the first and early second instar.

The control provided for Group (1) and (2) is of interest in that third instar larvae were able to live for 8 days without food. Some of them had pupated by the 8th day, whilst the majority of the second instar were dead.

The results were confirmed on July 7th, 1930, by a second experiment in which the larvae, after dipping infested rods into the emulsion, were sorted into two groups.

Group (1)—The larvae that walked off the foliage.

Group (2)—The larvae that remained on the willow rods for not less than 10 minutes after dipping. These rods were placed in a damp sand and covered with muslin bags to prevent the escape of the larvae.

The results observed 48 hours after treatment were as follows :—

<i>Group (1) Larvae.</i>		<i>Group (2) Larvae.</i>	
71	Third instar active.	63	Third instar active.
1	Pupa.	1	Second instar active.
5	Second instar active.	6	Third instar dead.
8	Third instar dead.	15	Second instar dead.
49	Second instar dead.		

It will be seen from the above that the majority of the third instar larvae were alive and active, and that the majority of the second instar larvae were dead.

These results were confirmed in small field experiments in which infested rods with foliage of various types were sprayed.

The reason for the variation in larval reaction towards the spray was investigated. That excess of Pyrethrum emulsion will kill third instar larvae is shown in the following experiment.

The larvae were placed in 2 mm. depth of the emulsion in a petri dish. At once the glandular products were poured out, and reacting with the emulsion altered its form. The excess of emulsion present, aided by the movements of the larvae, resulted in the glandular fluid being washed away and at the end of 7 minutes the larvae appeared dead. At this stage the larvae were removed and placed on a sheet of glass to air dry. No recoveries took place.

An examination under a binocular microscope of the reaction of the third instar larva to the application of a drop of Pyrethrum emulsion showed that the glandular product of the dorsal pro-



Sample of rods from plot sprayed with Pyrethrum extract.



Sample of Rods from unsprayed control plot.

trusible glands is of such quantity that the emulsion is washed off the body or considerably diluted. The larvae cover themselves with this glandular product on the slightest irritation and the finest mist spray, such as that carried in the air during spraying, is sufficient to cause protrusion of the glands and resulting protection before the full force of the spray comes on the larva.

The first instar larva has only two pairs of thoracic protrusible glands, and the amount of fluid secreted is insufficient to cover the body of the larva. In the second instar there is an increase in the number of functional glands, but the quantity of the secretion is not sufficient to protect the larva until the end of the instar.

The above data explain the apparent reason for the low mortality of the third instar larvae, and the high mortality of the first and second instar larvae, under normal spraying conditions. The protrusible glands protect the third instar larva against the toxic action of the Pyrethrum emulsion. This explanation receives some support from the reaction of the third instar larvae of *Galerucella lineola* (a Chrysomelid pest on willows) to Pyrethrum emulsion. The larvae are larger than those of *P. vitellinae* and do not possess any protrusible glands. They are killed by a light spraying with the emulsion.

The Toxicity of Pyrethrum Emulsion applied to Willow Foliage on Larvae. A rod of Brittany Green infested by third instar larvae was sprayed with freshly prepared emulsion. Within 15 minutes the larvae had walked off the rod. These were captured and replaced on the rod as soon as it had dried (one hour). A muslin bag was placed over the rod, and observations were made daily as to the effect of the sprayed foliage on the larvae. The results are as follows:—

June 18th.	19 larvae at commencement of the experiment.
„ 19th.	19 larvae feeding.
„ 20th.	19 larvae feeding, larvae changed to freshly sprayed dry foliage.
„ 21st.	19 larvae alive and about to pupate. Foliage eaten.
„ 24th.	19 pupae.
July 7th.	19 adults emerged.

From the above experiment it appears that the sprayed foliage had no toxic effects on the third instar larvae.

(b) Field Experiments.

In view of the above results and bearing in mind the facts that the larvae only feed on the lower surfaces of the leaves of the rods, and that the eggs are not killed by the emulsion, a number of small plots were selected for field experiments and sprayed about two days after the majority of the eggs had hatched.

The willows sprayed were, Leicester Dicks, Green Dicks and Brittany Green—varieties of *Salix purpurea*. The spraying was carried out on a dry sunny day, and particular care was taken to wet thoroughly the lower surface of the leaves. The emulsion was of the same strength as that used in the laboratory experiments, and was applied at the rate of 400 gallons per acre.

The sprayed bed and its control, being adjacent, were equally selected by the beetles for egg laying as was shown by a count made just before spraying. The estimation of damage was made at not less than 16 days after spraying, *i.e.*, at a time when the majority of the larvae were full grown and had gone to earth to pupate. The results are given below. The method of estimating the percentage of control obtained was as follows.

From each plot 250 rods were taken, the willow stools being selected at random, and all the rods on one stool being examined. The total length of the rod and the length of rod with foliage free from larval attack (unskeletonised leaves) were measured. Sound foliage consisted of those leaves not attacked by the larvae. The foliage commenced at approximately two inches from the base, and all measurements for the total length were taken from the stool. The results are as follows :—

<i>Sprayed Plot.</i>	Average length of unattacked portion of a rod ..	21	inches.
	Average length of a rod	26	”
	Actual percentage of foliage destroyed ..	19.7	”
<i>Control Plot.</i>	Average length of unattacked portion of a rod ..	6.7	”
	Average length of a rod	27	”
	Actual percentage of foliage destroyed ..	75.8	”

From the above figures it would appear that one application of Pyrethrum emulsion provided a satisfactory control. However the beetles of the same brood re-appeared in large numbers and re-commenced egg laying after the date of spraying (June 18th). In due course the eggs hatched and the larvae practically defoliated the willows as shown by the following results.

<i>Sprayed Plot.</i>	Average length of unattacked portion of a rod ..	6.0	inches.
	Average length of a rod	28.9	”
	Actual percentage of foliage destroyed ..	79.1	”
<i>Control Plot.</i>	Average length of unattacked portion of a rod ..	0.9	”
	Average length of a rod	26.4	”
	Actual percentage of foliage destroyed ..	91.7	”

This second estimation of foliage damage shows a marked increase in both plots, especially on the sprayed plot, and it clearly demonstrates the importance of applying more than one application of Pyrethrum emulsion when the oviposition of a brood of beetles occurs at two periods separated by more than about 10-14 days.

Provided egg laying by one brood of beetles is not interrupted by adverse conditions such as unfavourable weather, one spraying is sufficient. Such is exemplified in the following experiment.

A bed of Brittany Green, on which the majority of the eggs had been laid during the first week in June, was sprayed on June 18th. A second egg laying did not take place. The damage (see Plates) was estimated on July 4th, and the results are as follows :—

<i>Sprayed Plot.</i>			
Actual percentage of foliage destroyed ..	..	..	10.5
<i>Control Plot.</i>			
Actual percentage of foliage destroyed ..	..	..	68.7

An estimation made at a later date did not show any marked increase in damage by the larvae of this brood.

Experiments with Pyrethrum Dust.

The preparation employed consisted of the light petroleum extract of Pyrethrum, incorporated with kaolin as a carrier.

Only laboratory scale experiments were carried out.

The Toxic Effect on the Adults. A number of beetles were treated with the dust and kept under observation. It was noticed that effective adhesion did not occur owing to the shape and texture of the elytra. When large quantities of dust were applied death resulted, but the amount required was apparently too great to admit of its economic use in the field.

No noticeable control followed a generous dusting of a small heavily infested willow bed, the beetles falling from the foliage before any appreciable amount of dust lodged on them. A further difficulty was observed in that the dust did not adhere to the dry, glabrous foliage of such species as *Salix purpurea* and *S. alba vitellina*.

The Toxic Effect on the Larvae. A number of third instar larvae were dusted while feeding on the foliage and were kept under observation. Although toxic action had taken place during 24 hours following treatment the larvae managed to cling to the foliage, and at the end of two days were feeding normally, and no further ill effects resulted.

Examination of the larvae showed that adequate protection is afforded by the presence of several rows of long stiff setae which prevent close contact of the larger particles of the dust with the body wall, and by the products of the dorsal glands which wash off the smaller particles.

In a second experiment larvae were dusted with a hand-bellows

and then lightly rolled in the dust. They were then placed, touching one another, in an open dish. All power of movement was lost within 30 minutes, but the larvae responded to touch. Eighteen hours later the results were :—

Number of larvae dead ..	31 (1st and 2nd instars).
Number of larvae capable of movement	133 (3rd instar).

It was noted that the glandular fluid of the dorsal glands had formed large globules which stuck to the exhausted and now permanently protruding glands. Three days after the application of the dust all the larvae were dead except seven in their third instar which responded to touch.

From the above experiments, particularly the second in which the larvae received a far heavier and more evenly applied dressing than could be given under field conditions, it was concluded that the Pyrethrum dust would not provide a satisfactory means of control.

Experiments with Lead Arsenate.

From time to time lead arsenate has been recommended as a means of controlling this pest, but the results following its use have not been satisfactory. As it is recognised as an efficient stomach poison, investigations were carried out with the object of ascertaining the reasons for its failure. The following is a brief summary of the results :—

Laboratory Experiments.

- (1) A series of experiments were carried out in which a number of beetles were kept in muslin bags on foliage previously sprayed with lead arsenate at the strength of 1lb. to 18 gallons of water. The majority of the beetles continued to feed on arsenic-free portions of the leaves. Moreover it should be noted that the beetles are able to live without food for at least two weeks—a sufficient length of time to allow the growth of new foliage to which the beetles are immediately attracted.
- (2) The efficiency of lead arsenate as a stomach poison is dependent on the completeness of cover that can be obtained on the willow foliage.
- (3) Of the various spreaders tested out, Agral I. used at a concentration of 0.25% was found to be most satisfactory in giving even wetting of the foliage of all species of willows.

- (4) The larvae are killed soon after hatching from the egg on foliage sprayed with the lead arsenate.
- (5) The beetles neither feed nor lay eggs on the sprayed foliage.

Field Experiment.—The Control of Larval Damage.

A bed of Brittany Green was sprayed at the rate of 400 gallons per acre (11lb. lead arsenate to 18 gallons water, 0.25% Agral I.), care being taken to cover the lower surfaces of the leaves. Eggs were laid at two periods by the same brood of beetles (only once in the case of the sprayed plot). The spraying was carried out after the first oviposition. The larval damage was estimated in the same manner as that adopted in the Pyrethrum trials.

The results were as follows :—

<i>Sprayed Plot.</i>	Average length of unattacked portion of a rod ..	14.5 inches
	Average length of a rod	25 "
	Actual percentage of foliage destroyed	42.2 "
<i>Control Plot.</i>	Average length of unattacked portion of a rod ..	6 "
	Average length of a rod	21.3 "
	Actual percentage of foliage destroyed	71.2 "

The results were not entirely satisfactory (the sprayed plot rods lost half their foliage), but are better than the results obtained with one application of Pyrethrum emulsion (Table II). The bed was adjacent to the Pyrethrum plot, and was equally liable to suffer from the prolonged oviposition of the beetles. Lead arsenate provided a more lasting protection to the willow than Pyrethrum emulsion.

Determination of the Action of Lead Arsenate as a Repellent to Oviposition and as a Larvicide.

Two willow beds were selected.

- (a) Lancashire Dicks (*Salix purpurea*). A small leaved variety.
- (b) Golden Willow (*Salix alba vitellina*). A larger leaved variety.

Both beds were sprayed on August 21st, 1929, prior to oviposition by the second brood of beetles. The foliage was considerable, and over 400 gallons per acre of liquid were required to obtain a complete cover. The spray did not adhere to the foliage of *S. alba vitellina* so well as it did to the Lancashire Dicks.

The estimation of larval damage was made on September 13th before natural leaf fall had commenced. From each plot rods were selected at random, approximately 1,000 in the case of *S. purpurea*,

and all rods that had seven or more skeletonised leaves were counted as attacked; and in the case of *S. alba vitellina* approximately 500 rods were taken of which those with three or more leaves skeletonised were counted as attacked (an average sized batch of larvae require seven leaves of *S. purpurea* and three leaves of *S. alba vitellina* to attain full development). The results were as follows:—

Lancashire Dicks.

<i>Sprayed Plot.</i>	Total number of rods	..	..	..	1196	
	Number of rods attacked	..	..	..	68	= 6%
<i>Control Plot.</i>	Total number of rods	..	..	..	1016	
	Number of rods attacked	..	..	..	850	= 84%

Salix alba vitellina.

<i>Sprayed Plot.</i>	Total number of rods	..	..	..	541	
	Number of rods attacked	..	..	..	81	= 15%
<i>Control Plot.</i>	Total number of rods	..	..	..	543	
	Number of rods attacked	..	..	..	143	= 76%

The figures indicate that in the above experiment the lead arsenate acted as a repellent to egg laying and as a larvicide.* It was noticed that the lead arsenate persisted on the leaves, particularly the lower surfaces, despite heavy rains.

SUMMARY AND CONCLUSIONS.

1. The life-history of *Phyllodecta vitellina* is described.
2. Species of willows liable to attack are given.
3. Pyrethrum Emulsion is an efficient larvicide provided the first and early second instar larvae are sprayed.
4. Third instar larvae are protected by the glandular secretion of the dorsal protrusible glands, and are not killed by Pyrethrum Emulsion or Pyrethrum Dust.
5. Prolonged oviposition may render more than one application of Pyrethrum Emulsion necessary per brood of larvae.
6. Pyrethrum Emulsion or Dust will not provide an economical control of the adults.
7. Lead Arsenate, provided it is used in conjunction with an efficient spreader, is an efficient repellent to egg laying and also kills the larvae.

ACKNOWLEDGMENTS.

Thanks are due to the Colston Research Society for a grant towards the expenses of this investigation, and to a member of the Bristol University Zoological Laboratory Staff, Mr. M. Harris, for his able assistance.

*The larvae were killed after hatching. Nine batches of eggs were kept under observation, and in every case the larvae perished during the first instar.

PROGRESS REPORT ON VEGETABLE DISEASES.

BY LAWRENCE OGILVIE AND B. O. MULLIGAN.

The following report deals briefly with progress made towards the elucidation and control of diseases of vegetables in the Bristol Province, with special reference to the Evesham and Cheltenham areas. With a view to furthering this work Mr. J. W. Ewan was appointed by the Ministry of Agriculture as assistant mycologist for vegetable diseases and took up his duties on January 1st. He resigned to take up the post of Ministry's inspector and was succeeded by the junior writer on April 14th.

The present report is a continuation of that published last year (9).

ASPARAGUS DISEASES.

Violet Root Rot of Asparagus. (*Rhizoctonia Crocorum*, ? = *Helicobasidium purpureum*). Surveys of the Evesham asparagus area have revealed only two further very small centres of infection, both of considerable age. In view of the very slow spread of the disease the method of control at present adopted, namely, removal and thorough destruction by burning of all the affected roots, and planting the affected area with a non-susceptible crop, such as Brussels sprouts, appears to be satisfactory.

None of the other market garden crops in the vicinity of the diseased areas were affected, and of the common weeds of asparagus fields only *Rumex obtusifolius* was found to be attacked.

Asparagus "Sickness." As stated in last year's report there are strong indications that this condition is due to deficiency of potash. As work from the pathogenic point of view did not yield positive results, and as manurial trials carried out by other members of the staff now bear out this theory, detailed work on the trouble has been abandoned for the present.

Other Asparagus Diseases. There is no other important disease of asparagus in the Evesham area. *Zopfia rhizophila*, a fungus reported from asparagus on the Continent, was found in the Evesham area by G. C. Maltby in 1925. It was not again observed till the autumn of 1930, when it was discovered by us on some dead roots. It is not apparently associated with any definite disease symptoms. Experiments on its pathogenicity are to be carried out.

Lesions on asparagus stems bearing the fungus *Macrosporium commune* are not uncommon, but no positive results could be got by inoculation of pure cultures of this fungus on healthy stems.

DISEASES OF DWARF (FRENCH) BEANS.

Dry Root Rot. In last year's report (9) dry root rot or foot rot of dwarf beans, caused by *Fusarium martii* var. *Phaseoli*, was described. This disease had not been hitherto recorded from Great Britain. To prove further the pathogenicity of the fungus, the following experiments were carried out.

On January 28th, 1930, surface sterilised seeds of the following varieties were sown in sterilised soil:—"Canadian Wonder," "Dwarf Negro Longpod," "Dwarf Sharpe's Goliath," "Early Prolific" and "Masterpiece." Two pots of each variety were sown, each containing six seeds, and on February 4th one pot of each was watered with a suspension of spores from a pure culture of *F. martii* var. *Phaseoli*, isolated from plants from the Evesham area. The plants were grown in a warm greenhouse (60-65°F.) On April 2nd all the plants in the infected pots showed large red lesions on the stems. The fungus was re-isolated from these lesions.

On July 7th, 1930, surface sterilised seeds of the variety "Canadian Wonder" were sown in sterilised soil. The seeds had been soaked previously in water containing small pieces of mycelium. The plants were grown in a warm greenhouse, and on September 5th the following results were obtained:—

<i>Control.</i>		<i>Inoculated.</i>	
5	Healthy	4	Diseased out of 5.
5	do.	4	do.
4	Healthy, 1 failed to grow	4	do.
do.	do.	1	do.

The fungus was re-isolated from the above plants.

Through the courtesy of Mr. John Hall, Junr., of Bretforton, a variety trial was laid down in a badly affected piece of ground, with a view to determining whether any varieties were possibly resistant to the disease. In addition to common English varieties, some were obtained from Germany, but many of these proved unsuitable for market purposes on account of roughness, size, colour, or shape of pods. It was found that certain varieties which produced tough stems were more resistant to the disease than the others. The varieties were divided into categories as indicated below:—

Severely affected:—"Canadian Wonder," "Early Prolific,"

"Masterpiece," "Flageolet Crimson," "Dwarf Ne Plus Ultra," "Ne Plus Ultra" (Foreign seed).

Slightly affected, but unsuitable for market :—"Dark Dun Forcing," "Broadsword," "Best of All," "Everbearing," "Princess," "Emperor William," "North Star," "White Elsenburg" or "Longsword," "Thuringia," "Dwarf Negro Longpod" (Foreign seed).

Somewhat resistant :—"Flageolet Victoria" ("Magnum Bonum"), "Saxony," "Incomparable," "Flageolet St. Andrew," "Dwarf Sharpe's Goliath" (Foreign seed).

Further variety trials are to be carried out next season. It should be noted that in the United States, where this disease is of considerable importance, no strikingly resistant varieties have been found and long rotations are recommended.

Bacterial Disease. A bacterial disease of dwarf beans (*Phaseolus vulgaris*) is becoming of increasing importance in the Evesham area, where it is commonly referred to by growers as "rust." It is apparently of fairly recent introduction. The most striking symptom of the disease, and one which is very noticeable in the field, is a sudden wilting of the whole or part of the plant. The leaves shrivel up and become brown, but remain attached to the plant. In the field large patches of plants may become so affected, the infection usually radiating from diseased plants. The wilting is due to invasion of the vascular system of the plant by bacteria.

On the leaves definite small angular water-soaked areas occur, surrounded by a light coloured halo, or there may be an abundance of small infections, giving the leaf a scorched appearance.

The longitudinal lesions which occur on the stem, at first green and water-soaked, but later reddish in colour are characteristic of the disease. From these lesions a milky white bacterial ooze is produced in the form of drops or tendrils.

Somewhat circular water-soaked lesions are produced on the pods. If infected at an early stage the pods become curled and twisted and reddish brown streaks may occur. A bacterial ooze may arise on the exterior or interior of the pods.

Seeds from infected pods exhibit much wrinkled maize-yellow spots on the seed-coat, underneath which copious bacteria may be found.

The disease was widespread in the bean plantings near Evesham and the varieties affected were "Canadian Wonder," "Masterpiece" and "Early Prolific." In some cases diseased plants had to be grubbed before they had podded.

The bacteria responsible have been isolated in pure culture and have reproduced the characteristic symptoms when inoculated on bean plants. Work is being done to establish their identity. The disease has been tentatively identified as "halo blight," described by Burkholder (3, 4). This disease, caused by *Bacterium* (*Phytomonas*) *Medicaginis* var. *phaseolicola*, is the most serious of the bacterial diseases of the bean occurring in New York State. According to Burkholder, no other bacterial disease of beans produces an ooze or exudate from the stem lesions, and the halo-like leaf spot caused by *B. (Phyt.) Medicaginis* var. *phaseolicola* is a symptom which can scarcely be mistaken or confused with other leaf spots. The cultural characters of the organisms, as far as they have been studied, also agree with this identification.

"Halo blight" has been recorded from Germany, where it is known as "grease-spot disease" (11), and was also observed in Switzerland by Burkholder, but there is no record of its occurrence in England. It should be noted, however, that the bacterial leaf blotch of dwarf beans, caused by *Bacterium Phaseoli*, E. F. Smith, has been recorded from England, the causal organism having been isolated successfully (6).

To demonstrate that the disease could be transmitted by growing plants in soil containing debris from infected beans, four pots containing sterilised soil were sown with seeds of the variety "Canadian Wonder," which had been previously surface sterilised. To two of the pots were added pieces of diseased stems and pods gathered from the field. The seeds in the control pots produced healthy plants, while one of the infected pots produced five heavily infected plants. The other infected pot produced healthy plants.

Of four similar pots sown on September 15th, 1930, four with infected pods added, and one control pot, the three infected pots produced 3, 5 and 2 infected plants out of 5 plants in every case, while the control pot produced healthy plants.

The methods of control advocated for this disease are :—

(1) The use, if possible, of bean varieties which show some resistance. Several somewhat resistant varieties are known in New York State, and trials of these and English varieties are to be carried out next season.

(2) The use of disease-free seed. There is no doubt that infected seed is the common mode of dissemination of the disease, and the attention of seedsmen should be drawn to its importance. It should be possible for growers to save disease-free seed from their own fields.

In cases where a small initial infection occurs in a field it might be possible to grub up the infected plants and so prevent further spread.

DISEASES OF BROAD BEANS.

Chocolate Spot, etc. An investigation of diseases of broad beans was carried out in conjunction with Dr. R. Woodward, of Oxford. It was found that several diseases of beans could be differentiated, some of which had apparently been confused in the past with "chocolate spot" (supposed to be caused by *Bacillus Lathyri*). A leaf spot due to *Cercospora Fabae* was very prevalent in Herefordshire from the end of February onwards. What was apparently true "chocolate spot" was common in Somerset in early spring. Control trials of both diseases were laid down in March, sulphur and copper-lime dusts being used, but it was found that by the beginning of May healthy and control plants had grown away satisfactorily from the disease, the top leaves being free from spots.

Several cases of leaf-spotting accompanied by discolouration of the bases of the stems were ascribed to frost damage.

Ascochyta Fabae was present in most of the fields, and both this and the other leaf spots were frequently followed by *Botrytis cinerea*, which often killed off the tips of the shoots.

DISEASES OF SUGAR BEETS.

Heart Rot. An investigation is being carried out on "heart rot" of sugar beets, in co-operation with Mr. A. W. Ling, Agricultural Adviser, Bristol University, to determine whether the disease can be produced by growing sugar beets in certain soils, either with or without the presence of *Phoma Betae*.

LEEK DISEASES.

White Tip Disease. This disease, first recorded by C. E. Foister from the Edinburgh district in 1928 (5), was found in the Cheltenham area in 1929, where it is now causing considerable loss. Preserved specimens of leeks, supposedly attacked by bacterial soft rot, gathered in a market garden at St. George, Bristol, in 1928, have also been found to contain the causative fungus. In the same market garden an acre of the variety "The Lyon" was heavily infected in 1930.

As indicated by Foister, the tips of the leaves die back, the affected area becoming white, while water-logged areas develop towards the middle or base of the leaf. It was found by us that infections often commence at the point where the leaf bends over,

but a definite break is not necessary. If the base of the leaf becomes infected, the whole leaf-blade may wilt and the affected area become more water-soaked than usual. The disease may check the growth of the plants very severely, rendering them useless for market purposes.

Foister has shown that the associated fungus is a *Phytophthora*. Attempts have been made by him, by S. F. Ashby, of the Imperial Bureau of Mycology, and by ourselves to obtain the fungus in pure culture, but without success.

Measurements of spores as developed on the leaves are as follows :—

<i>Oogonia.</i>	Foister	.. .. .	27-39 μ
	Ashby (Cheltenham material)	..	25-38 μ
	O. & M. (do.)	..	33-40 μ
<i>Oospores.</i>	Foister	.. .. .	20-31 μ
	Ashby (Cheltenham material)	..	20-32 μ (mean 27 μ)
	O. & M. (do.)	..	27-40 μ (mean 36 μ)
<i>Sporangia.</i>	Foister	.. .. .	37-75 $\times$ 31-48 μ (mean 58 $\times$ 42 μ)
	Ashby (Cheltenham material)	..	37-70 $\times$ 29-49 μ (mean 51 $\times$ 38 μ)
	O. & M. (do.)	..	43-76 $\times$ 29-43 μ (mean 58 $\times$ 38 μ)

The measurements made by Ashby were from mycelium developing from dry leek leaves which had been kept in the laboratory for several weeks. It was found by us that such leaves would produce a practically pure culture of the *Phytophthora* if soaked in water for three or four days. Ashby reports in our material both paragynous and amphigynous antheridia, about a quarter being of the latter type. The sporangia appear to be of the type with a shallow, broad, hyaline apical layer resembling those of *P. Syringae*.

Ashby notes the resemblance of the fungus to *P. Pini* Leonian. We have obtained cultures of this fungus, but our inoculations have not been successful. Neither does the leek *Phytophthora* agree with the diagnosis of *P. Allii* recorded on *Allium* in Japan.

The disease has appeared in the autumn of 1930 in the same spots as in 1929. Through the kindness of Mr. W. H. Hole, of Cheltenham, a trial of 17 varieties of leeks has been laid down on infected ground, while part of this plot is being used for a fungicidal trial. The varieties "The Lyon" and "Musselburgh" are those usually grown and most severely affected in the field. Individual, apparently resistant plants have also been observed and these are being kept for seed.

Bacterial Soft Rot of Leeks. A bacterial soft rot (probably due to *B. carotovorus*) was found in the Evesham area, affecting the variety "The Lyon."

LETTUCE DISEASES.

Ring Spot. Usually known as "rust," this disease, caused by the fungus *Marssonina panattoniana*, is prevalent throughout the Province, and is found especially in market gardens where lettuce has been grown over a long period. Elongated sunken pale-brown spots appear on the under-surface of the midrib and these, accompanied by small brownish spots on the leaf blade, give the lettuce an unsightly appearance. Seedling plants may be so severely affected as to die off.

Variety trials are being carried out against this disease on infected soil. The variety "MacHattie's Giant" has not been found to be so resistant as is commonly supposed. In field practice it is usually found that later plantings are not so liable to infection. Rotation of the crop should be carried out in badly affected areas wherever possible.

Bacterial Spot and Marginal Scorch. A bacterial spot and marginal scorch is common throughout the area, and was prevalent on lettuces grown for experimental purposes in the Long Ashton greenhouses. This disease is being worked on, and is probably identical with the bacterial spot (caused by *Bacterium marginale*), described from the United States by Miss N. A. Brown(2) and recorded from this country by Paine (10). It is possible that a non-pathogenic marginal scorch may also occur.

Pleospora Leaf Spot. A leaf spot apparently undescribed previously was observed in April 1930 on the variety "Stanstead Park" in greenhouses near Taunton, and since then has been found on plants grown out of doors in Worcestershire, Gloucestershire and Somerset on the varieties "MacHattie's Giant," "Winter White" and "Lee's Immense." The first symptoms are small, light brown spots on the leaf blade, usually roughly circular, though sometimes angular or oblong. The spots may coalesce and involve a large area of the leaf, which becomes brown and shrivelled. The centres of the spots on the outer leaves may fall out, producing a shot-hole effect. The spots have frequently a dark brown circumference or a number of concentric rings.

On the old spots *Macrosporium* spores are borne abundantly. The fungus grows readily on malt extract agar, producing dark brown "sarcinula" *Macrosporium* spores measuring $20-36 \times 16-25\mu$ (av. $30 \times 19\mu$) and also, after some three weeks, perithecia of the genus *Pleospora*, with muriform ascospores with seven cross septa, measuring $39 \times 18\mu$. The perithecial stage is ascribed to *Pleospora herbarum* (Pers.) Rabenh., while the *Macrosporium* stage agrees with *M. sarcinula* Berk. emend. Bolle.

Lettuce plants have been artificially infected with the fungus by spraying the leaves with a spore suspension and the fungus has been re-isolated.*

Stem Rot. This disease is prevalent in the market garden areas around Bristol. In several cases over 80% of the plants were affected. The symptoms are a rotting of the inside of the stem, accompanied by a pinkish and later a brownish colour. The affected area subsequently rots away entirely and the stem breaks off near the surface of the ground, the condition resembling cut-worm injury. A yellow bacterium was isolated by us and is being worked on. A yellow organism was isolated by Dr. S. G. Paine from material sent to him. The latter resembled very closely *B. vitians*, described by Miss N. A. Brown, as causing a similar lettuce disease in the United States (2).

? *Mosaic.* A condition much resembling mosaic was observed on plants sent us from Middlesex, on others of the variety "Peerless," raised from seed at Long Ashton, and on plants at Cheltenham. The leaves were very definitely mottled with irregular dark green and pale green areas, and the plants failed to heart.

Attempts were made to transmit this condition to healthy seedlings by rubbing diseased on healthy leaves and by transferring the aphid *Macrosiphum gei* from diseased to healthy plants, but without success.

It was thought not impossible that the symptoms might be due to deficiency of some essential chemical in the soil, and with this in view three applications were made of acid potassium phosphate ($\frac{1}{4}$ oz. per gallon), potassium sulphate ($\frac{1}{2}$ oz. per gallon) and ammonium sulphate ($\frac{1}{2}$ oz. per gallon) at intervals of ten days, but these did not remove the symptoms, though in the case of the phosphatic solution some improvement was noticeable.

Sclerotinia Disease. A lettuce "drop" and soft rot due to *Sclerotinia Sclerotiorum* was observed in the Cheltenham area; control may be obtained by removing the diseased plants, together with the soil round their roots, and then watering the spot with a solution of formalin—1-50.

Miscellaneous Lettuce Diseases. A condition prevalent in the Cheltenham area, and apparently of much importance, is a very marked curling or puckering of the leaves accompanied by failure to heart. In Cos varieties this is accompanied by considerable dwarfing. It was thought that the plants in question might be "rogues" and with this in view trials of the variety "MacHattie's

*See Ogilvie L. and Mulligan, B.O., "A Leaf Spot Disease of Lettuce due to *Pleospora herbarum*." Gard. Chron., Vol. 89, No. 2298, p.35, Jan. 10, 1931.

Giant " from six sources were set out at the Institute. An average of about 2% of the curly plants in question appeared in the rows. This percentage is much less than the incidence of the condition in the field, where it appears to an extent of at least 10% in the variety " MacHattie's Giant."

DISEASES OF MINT.

Mint Rust (Puccinia Menthae). This rust is of much economic importance in the Cheltenham area, where mint is forced in greenhouses. The factors governing epidemics of the rust in greenhouses are not properly understood and control measures are being attempted from various angles.

DISEASES OF ONIONS.

White Rot (Sclerotium cepivorum). Trials are being carried out of various strains of the bunching onions, " White Welsh " and " White Lisbon," with a view to ascertaining their susceptibility to white rot.

PARSNIP DISEASES.

Parsnip " Canker." Parsnip " canker " causes severe losses to growers in the area. The trouble is being investigated as it is thought that several diseases may be implicated.

DISEASES OF PEAS.

Foot Rot. A foot rot of peas associated with a species of *Fusarium* and very prevalent in the Evesham area was referred to in last year's report. The symptoms of the disease are a dying off of the plants at the time of podding. The affected plants show dark brown to purplish streaks on the lower part of the stem, and particularly near its junction with the roots. The stem is somewhat constricted over the affected area and is easily broken at or below soil level. The disease tends to spread downwards into the roots, which develop the characteristic streaking and may finally rot off.

A *Fusarium* was isolated constantly from diseased plants in the area. With a view to proving its pathogenicity a number of greenhouse experiments were carried out.

1. On August 15th, 1929, two dozen surface sterilised seeds of the variety " Telegraph " were sown in steam-sterilised soil in pots infected with the fungus mycelium, while two dozen seeds were similarly sown in sterile soil. On September 15th, 1929, all the plants in the infected soil showed the characteristic lesions while those in the sterile soil remained clean.

2. On February 5th, 1930, seeds of twelve varieties were sown in pots in the same way. Two pots of each variety were sown, each pot containing four seeds. On February 6th one pot of each variety was watered with a suspension of spores from a culture of the *Fusarium*.

The plants were lifted on May 14th, 1930, and the following results were obtained :—

Variety.	Average Height		Average Height		Remarks on
	of	Controls.	of	Diseased Plants.	
Pilot (English seed) ..	35	inches	38	inches	Foot-rot slight.
Talisman (English) ..	32	"	25	"	Foot-rot severe.
Sharpe's Renown (English)	41	"	30	"	Slight Foot-rot.
Liberty (English) ..	32	"	29	"	Foot-rot severe.
Gradus Improved (English)	44	"	31	"	Foot-rot (one severe).
Meteor (Foreign) ..	16	"	19	"	Foot-rot.
President (English) ..	30	"	26	"	Very slight Foot-rot
Marvellous (English) ..	20	"	17	"	One severe, other three slight Foot-rot.
Eldorado (English) ..	12	"	13	"	Foot-rot.
Unique (English) ..	16	"	12	"	Foot-rot.
Queen (English) ..	24	"	27	"	Foot-rot.
Standard (English) ..	33	"	42	"	Foot-rot.

All the control plants remained free from the disease except one of the "Gradus Improved."

3. On July 8th, 1930, two pots of sterilised soil were sown with six seeds of the variety "Carter's Eight Weeks," which had been soaked in water in which pieces of the fungus mycelium had been teased up. One pot was used as control.

Three pots were sown similarly with the variety "Eclipse." The plants were then grown in a cool greenhouse. The plants were examined on August 14th with the following results :—

	Carter's Eight Weeks.		Eclipse.
Control ..	Six healthy plants..	..	Six healthy plants.
1st infected pot ..	Five diseased plants (one not germinated).		Six diseased plants.
2nd infected pot ..	Five diseased plants (one not germinated).		Six diseased plants.

The variety "Carter's Eight Weeks" was very badly attacked, several plants beginning to die off at the base, whereas the variety "Eclipse" was still healthy in appearance above ground, though the stems were blackened at soil level.

Following is a description of the cultural characters and spore measurements of the fungus. The final characteristics were noted after the cultures had been kept for 40 days at 25°C.

On Potato Dextrose Agar. Mycelium whitish to sea-shell pink;* substratum becoming vinaceous and finally chocolate to burnt umber.

On Oatmeal Agar. Extremely poor growth.

On Malt Extract Agar. Vigorous white mycelium with slightly brownish tinge, becoming pale brownish drab to vinaceous drab; pseudopionnotes artemisia green to lily green.

On Sterile Potato Plugs. Mycelium at first white, becoming pale brownish drab to vinaceous drab, chestnut when in contact with glass; pseudopionnotes dark greyish blue-green to Saccardo's slate.

On Steamed Rice. Mycelium pale vinaceous, with a blue colour in contact with the glass; medium becoming coloured dark mineral red to dark Indian red.

On Sterilised Clover Stem. Fair growth of greyish-white mycelium; abundant production of sporodochia.

The diagnosis agrees with *Fusarium martii* var. *Pisi*, described by F. R. Jones (7) as causing a stem and root rot of peas in the United States. The disease in question is distributed very thoroughly throughout most of the pea-growing areas in the United States.

Through the co-operation of Mr. John Hall, Junr., of Bretforton, Worcester, a trial of 41 varieties of peas was laid down in March in a plot of infected soil. The following observations were made on July 15th, 1930 :—

Severely infected :—Thomas Laxton, Eclipse, Early Bird, Pioneer, Blue Bird, Freedom, Laxton's Superb, Primo, Laxtonian, Laxton's Progress, Meteor, Pilot, Eldorado, Unique, Marvellous, Hundred-fold, Talisman, Kelvedon Wonder, Bedfordshire Champion, Tip Top.

Badly infected :—Little Marvel, Pioneer, Early Giant Marrow-fat, Gradus, Admiral Beatty.

Slightly infected :—British Lion, World's Record, Gradus Improved.

Apparently somewhat resistant :—Lincoln, Alderman, Senator, Dwarf Defiance, Cheltonian, Duke of Albany, Witham Wonder, Standard, President, Liberty, Queen, The Gladstone, Royal Salute.

* Ridgway's "Colour Standards."

The average spore measurements in μ on various media are as follows :—

SHOWING AVERAGE SPORE MEASUREMENTS IN μ ON VARIOUS MEDIA.

F. R. JONES.

	Age of Culture.			
	0—	1—	2—	3—
Oat agar	..	..	..	..
%	11.0 $\times$ 2.4	—	—	31.7 $\times$ 4.3
Potato agar	..	1.0	10.0	85.0
%	7.0 $\times$ 2.3	20.4 $\times$ 3.5	30.6 $\times$ 4.0	32.0 $\times$ 4.2
Potato dextrose agar	..	12.0	29.0	54.0
%	9.0 $\times$ 2.3	—	—	32.0 $\times$ 4.0
	..	5.0	—	93.5
	..	—	—	39.0 $\times$ 4.0
	..	—	—	1.0
Ogilvie & Mulligan.				
Malt extract agar	..	27.5 $\times$ 5.0	27.7 $\times$ 4.7	30.6 $\times$ 4.8
%	3.6	28.6	30.3	35.7
Potato dextrose agar	..	24.2 $\times$ 5.0	28.7 $\times$ 5.2	31.5 $\times$ 5.4
%	—	50.0	35.0	10.0
Potato plug	..	24.8 $\times$ 5.4	25.8 $\times$ 4.3	31.4 $\times$ 5.3
%	8.3	20.8	25.0	41.7
Potato plug	..	24.1 $\times$ 4.7	31.8 $\times$ 5.4	37.7 $\times$ 5.8
%	—	6.7	20.0	73.3
Rice	..	28.3 $\times$ 5.0	29.3 $\times$ 5.1	39.7 $\times$ 5.9
%	—	18.4	34.2	44.8
	..	—	—	47.2 $\times$ 6.8*
	..	—	—	2.6

Chlamydospores present on 44 days old cultures on potato dextrose agar and rice.

* Only one spore seen and measured.

We are indebted to Messrs. W. W. Johnson, Boston ; Messrs. Sharpe, Sleaford ; Messrs. H. J. Speed, Evesham ; and Messrs. Yates, Evesham, for seed samples. Similar trials are to be carried out next season.

According to Jones a comparatively high soil temperature, above 18°C., favours rapid development of the disease as it occurs in the United States, while soils containing much organic matter appear to favour the persistence of the fungus in the field. No evidence of dissemination of the fungus by seed was obtained by him, and he is of opinion that it is a widely distributed soil organism, having physiological varieties capable of varying degrees of pathogenicity.

It may be noted that an apparently identical *Fusarium* was isolated by us from the roots of wilted sweet pea plants, but no successful results were obtained by inoculation on sweet peas.

"Spot" Disease (*Ascochyta Pisi*). In May 1930 specimens of pea plants affected with "foot rot" were received from Worcestershire, with the report that two acres of plants had been so severely affected that they had to be ploughed in. The lesions on the plants were typical of those caused by *Ascochyta Pisi*, being brown and sunken, and occurred mainly at or below ground level.

The fungus *Ascochyta Pisi* was isolated from this material and used in a series of pot experiments as follows:—Six surface-sterilised seeds of twelve varieties were sown in each of twelve pots in steam-sterilised soil. In Nos. 1 to 6 mycelium of the fungus was added, in Nos. 7 to 12 pieces of diseased root. The results were as follows:—

Variety.		Diseased.		Healthy.	Notes.
1.	Blue Bird	2	4	—	—
2.	Progress	5	1	—	—
3.	Alderman	4	—	—	One failed to germinate. Two died when lin. in height.
4.	Telegraph	3	3	—	—
5.	Carter's Eight Weeks ..	3	3	—	Disease only slight.
6.	do.	4	2	—	do.
7.	Superb	5	—	—	—
8.	Eclipse	6	—	—	Severe only in one case.
9.	British Lion	5	—	—	One failed to germinate.
10.	Freedom	5	—	—	Do. Disease severe.
11.	Carter's Eight Weeks ..	3	3	—	Lesions at base of stem only.
12.	do.	6	—	—	do.

The symptoms of disease in most of these cases were the occurrence of brown sunken lesions at the bases of the stems, accompanied by sunken lesions higher up. There was not usually any leaf infection.

The above case is of much interest in so far as L. K. Jones in his studies of *Ascochyta Pisi* in the United States (8), has shown that there this fungus never causes the appearance of stem lesions extending below the surface of the ground.

The pod and leaf spot caused by *Ascochyta Pisi* was very prevalent in the Evesham and Cheltenham areas in 1930, rendering the crop in many cases almost unsaleable.

The disease may over-winter, according to L. K. Jones, either in old pea refuse or in or on the seed. Preliminary experiments with a view to at least partial control were carried out as follows, the number of seeds employed being few owing to difficulty in procuring infected seed.

Four pots of seed from infected plants were sown on October 20th. In two the seeds were treated with a proprietary mercury dust previous to sowing; the other two were untreated. Out of seven seeds sown in each pot only one and two respectively germinated in the former, and seven and five in the latter. Apparently, therefore, the treatment is too severe.

Another experiment was carried out with hot water, as used by Jensen for sterilisation of barley seed infected with *Helminthosporium*, the seeds being subjected to water of a temperature of 52°C. for twelve minutes. Five seeds were sown in each pot. Germination was two, four and three seeds respectively and three in a control pot. Of all these only one plant in each of the second and third pots was unaffected. Further hot water treatments are to be carried out next season.

In a third experiment infected seeds were soaked in a 1:1000 solution of mercuric chloride for three minutes. Five seeds were sown in each of two pots of sterilised soil and two other pots were sown as controls. The results may be tabulated thus:—

Pot.	Germination.	Diseased Plants.	Healthy Plants.	
1	5	4	1	} Treated.
2	2	—	2	
3	4	2	2	
4	1	—	—	} Untreated.

It is apparent that this method also fails to give successful control.

Bacterial Disease of Peas. The bacterial disease referred to in last year's report was not observed in 1930.

POTATO DISEASES.

Potato "Sickness." Potato "sickness," associated with the eelworm *Heterodera Schachtii*, and the fungus *Corticium (Rhizoctonia) Solani*, and frequently with the fungus *Colletotrichum atramentarium*, has become of serious importance to allotment holders in the neighbourhood of Bristol. On allotments at Ashton Gate, near Bristol, the disease has been present for about twelve years. The affected areas are very sharply defined.

A small experiment was carried out in the greenhouses at Long Ashton in 1929. Briefly, three series of pots were planted up in August with tubers of the variety "King Edward"—

- | | | |
|----|-----------------------|---|
| 1. | Potato-sick soil. | |
| 2. | Non-potato-sick soil. | |
| 3. | do. | with a culture of <i>C. Solani</i>
from "sick" potatoes. |

Under the abnormal greenhouse conditions series 2 and 3 grew very tall, 3 feet in height, but the leaves were dark green and of normal appearance, although in series 3 the roots and the base of the stems were covered with *Rhizoctonia* mycelium.

Series 1 were less than half the height of the others, were markedly spindly and pale in colour, and the leaves were slightly rolled upwards, the petioles arising from the stem at an acute angle, symptoms identical with those occurring in the field. The roots of these plants were thickly covered with encysted females of the eelworm. Six weeks after planting little *Rhizoctonia* mycelium could be found on the roots, but a considerable amount was present five weeks later. *Colletotrichum atramentarium* was abundantly present on the roots of all the plants grown on the "sick" soil, but was absent from the roots of the other series.

That tomato plants can be affected with the disease is shown by the following. Five young tomato plants were potted up in Potato "sick" soil on May 4th, 1930, and on the same date five in potting soil from Long Ashton. When the plants were examined on June 19th, 1930, the average height of the plants in potato "sick" soil was 7 in., while that of the control plants was 20 in. The roots of all the plants in the potato "sick" soil were affected with eelworm, *Rhizoctonia* and *Colletotrichum*, while those of the check plants were clean.

It has hitherto been supposed that the eelworm and *Rhizoctonia Solani* are chiefly responsible for the disease, but in our opinion the role of the *Colletotrichum* possibly in conjunction with the other two, should be more fully investigated.

With the co-operation of the Hotwells and District Allotment Association several preliminary trials of the effect of chemicals on the disease were carried out on severely affected ground. The following materials were employed:—Sulphur (3 oz. per sq. yd.); cresylic acid, *i.e.*, mixed cresols (1/9th oz. per sq. yd., mixed with 1 stone of sand per plot of 18 sq. yds.); formalin (4½ gallons 1 in 50 formaldehyde soln. per sq. yd.); copper sulphate (2¼ oz. per sq. yd.); Cheshunt compound (4½ gallons per sq. yd.). The plots employed measured 7 by 3 yds., a strip of 3 sq. yds. in the centre being used as control.

The sulphur, cresylic acid and cresol plots gave no appreciable control as compared with the control strips. A marked control was, however, obtained with copper sulphate and with formalin as will be seen from the following results:—

Yield from Plot of 9 Square Yards.

A. 1. Formalin (4½ gallons 1 : 50 formaldehyde soln. per sq. yd. watered on)	.. .. .	13.7 lb.
2. Formalin (do. but plot covered over for 2 days)	.. .. .	14.4 lb.
3. Control plot. No treatment	.. .. .	6.6 oz.
B. 1. Copper Sulphate (2¼ oz. per sq. yd. watered on)	.. .. .	34.5 lb.
2. Cheshunt Compound soln. (4½ gallons per sq. yd.)	.. .. .	23 lb.
3. Control plot	.. .. .	22½ lb.

The plot B was apparently not so heavily affected as plot A.

In view of the possibility of certain potato varieties being resistant to "sickness" two variety trials were carried out. For both of these the "seed" was supplied free of charge by Messrs. Sutton & Sons.

The first trial was laid down in allotments near Bristol, through the kindness of the Hotwells and District Allotment Association, Ltd. "Arran Chief" planted on the plot during the previous year had been a total failure. Eighteen tubers of each of seven varieties were planted longitudinally and fourteen tubers each of two varieties were planted transversely. The tubers were planted on April 16th, and the early varieties dug on August 6th, the remainder on September 9th. The yield of each plant was weighed separately. The average yields per plant were as follows:—"King Edward," 22 oz.; "Arran Chief," 19 oz.; "Up-to-date," 16 oz.; "Edgecote Purple," 15 oz.; "Arran Victory," 14 oz.; "Stirling Castle," 12 oz.; "May Queen," 11 oz.; "Epicure," 11 oz.; "British Queen," 7 oz.

The second trial was laid down at Bristol Mental Institute, Fishponds, through the kindness of the Director and Mr. J. Merrick, head gardener. The crop last year on this piece of ground was a

failure owing to potato sickness. The land is scheduled for wart disease, hence only immune varieties were planted. Seventeen varieties were planted transversely and two rows of one variety longitudinally. The tubers were planted on April 28th, the early varieties dug on September 3rd, and the remainder on October 2nd. The yield of each plant was weighed separately. The average yields per plant were as follows:—"Kerr's Pink," 18 oz.; "Perth Favourite," 18 oz.; "Arran Victory," 16 oz.; "Abundance," 16 oz.; "Inverness Favourite," 14 oz.; "White City," 14 oz.; "Ally," 13 oz.; "Arran Consul," 13 oz.; "Tinwald Perfection," 13 oz.; "Ben Cruachan," 12 oz.; "Great Scot," 12 oz.; "Majestic," 12 oz.; "King George," 12 oz.; "Edgecote Purple," 12 oz.; "Arran Comrade," 7 oz.; "Glasgow Favourite," 7 oz.; "Ben Lomond," 6 oz.; "Catriona," 6 oz. The yield of "Great Scot" in uninfected areas of the same field averages about 5 lb. per plant.

It was previously thought that purple varieties such as "Arran Victory" and "Edgecote Purple" showed some slight resistance to the disease. The above trials seem to indicate that none of the 27 varieties under trial can be confidently recommended for planting on "potato sick" ground.

Potato Blight. The following experiment was laid out under instructions from the Ministry of Agriculture's Plant Pathological Laboratories, the object being to ascertain whether, when potato blight makes its appearance, the younger plants are more resistant to infection. A plot of ground approximately 1 square perch in area was divided into eight equal squares, and on which twelve tubers of the variety "King Edward" were planted at intervals of about a fortnight. The whole was surrounded by a large area also planted on April 17th, 1930, with the variety "King Edward."

The following results were obtained:—

Plot 1. Planted April 28th.		On Sept. 12th.		100% plants blighted (more than two leaves with all leaflets blighted).		
"	2.	"	May 15th	"	83%	" "
"	3.	"	June 2nd	"	100%	" "
"	4.	"	June 16th	"	92%	" "
"	5.	"	July 1st	"	100%	" "
"	6.	"	July 12th	"	42%	" "
"	7.	"	July 28th	"	75%	" "
"	8.	"	August 13th	"	0%	" "

Blight was first observed on August 13th.

There seems to be no correlation between the age of the plant and the amount of infection except in the case of the very youngest plants.

A quantity of tubers of the supposedly resistant variety "Keay's Champion" was also received for trial. These were planted on April 28th. The plot had entirely dried up with blight by September 1st. On this date the surrounding "King Edward" was much the same although a few green tips still remained.

DISEASES OF VEGETABLE MARROW.

Mosaic. A mosaic disease of vegetable marrows was first observed in the Province in 1928. The symptoms of the disease are a very marked mottling of the leaves, taking the form of pale yellow markings which tend to run in wavy lines or circles. The leaves also tend to become puckered. Affected shoots have decidedly shortened internodes and a tendency to branch. The affected fruits are mottled and covered with somewhat circular wart-like areas. All the young leaves and shoots of an infected plant ultimately show the symptoms, but the older leaves remain apparently normal. Much of the young fruit dries off without developing.

In 1928 and again this year *Aphis gossypii*, one of the chief vectors of cucurbit mosaic in the United States, and of cucumber mosaic in greenhouses in England, was found on marrows growing out-of-doors. Other insects prevalent on marrows were *Macrosiphum gei*, *Aphis rumicis* and a plant bug, *Dicyphus errans* (identified by Dr. Harry Britten).

As there appeared to be some evidence of the spread of the disease in the field, various attempts were made to transmit it from diseased to healthy plants under cages by rubbing and by means of *Aphis gossypii*, which was thought to be the most likely vector. Up to the present there appears to be some evidence that the disease is transmissible both by rubbing and by the aphid, as in the case of cucurbit mosaic in the United States, but transmission is by no means easy and further research is required.

The disease is apparently transmitted through the seed, as Bewley (1) has shown in the case of cucumber mosaic, and we have encountered several plantings in which a large percentage of young plants came up infected. Seeds kept from infected plants, however, have not yet given us infected plants.

Plants of white bryony (*Bryonia dioica*), growing in the neighbourhood of plantings of marrows, have been found to have mottled leaves suggestive of mosaic infection, but our attempts to transmit marrow mosaic to white bryony seedlings by rubbing and by means of *Aphis gossypii* have been uniformly unsuccessful.

The disease is apparently becoming much more prevalent than formerly, and is attracting the attention of growers. Thus in one planting brought to our attention, 35% bush marrows and 25% trailing plants were infected, and in another 100% bush and 89% trailing. In a third practically all the plants, 200 in number—both bush and trailing, were affected. Although 48 plants were grown by us under controlled conditions from the same batch of seed as the above, no mosaic plants were obtained.

Mildew. Vegetable marrow mildew (*Erysiphe Cichoracearum*) is of importance to growers as it causes the plants to wither off and fruit production to cease a considerable time before natural dying off of the plants takes place.

With a view to ascertaining the effect of various sulphur dusts on the disease a trial was laid down at the farm of Mr. W. H. Hole, Swindon Road, Cheltenham. The plot in question consisted of six rows of marrows with approximately 35 plants in each row. On August 26th, 1930, applications of green sulphur, ground sulphur and a proprietary sulphur dust were made to three of the rows, the other three being left as controls. On that date mildew was just beginning to appear on the plants. The weather at the time was very warm and dry.

On October 10th, 1930, observations were made on the amount of disease on the plants, the amount of mildew on the leaves being divided into four categories—severe, slight, very slight and free. The results were as follows:—

Control row 1	27 severe	6 slight	
Green sulphur	1 slight	8 very slight	29 free.
Control row 2	20 severe	15 slight	2 very slight.
Ground sulphur	1 slight	6 very slight	27 free.
Control row 3	30 severe	8 slight.	
Proprietary dust	1 severe	4 slight	1 very slight, 29 free.

In another trial applications of fungicides were interfered with by heavy rainstorms, but the following broad results were obtained. The applications were made on August 7th, 1930, and observations made on September 9th:—

1. *Green sulphur* Mildew present only on a few shoots or isolated patches of leaves.
2. *Ground sulphur* Similar to preceding.
3. *Copper lime dust* Mildew very severe.
4. *Proprietary sulphur dust* .. Row quite green, with many young shoots.
5. *Bordeaux mixture (4-4-40)* .. Badly affected. No appreciable difference from control rows.
6. *Burgundy mixture (4-5-50)* .. do.
7. *Ammonium polysulphide (1-200)* .. do.
8. *Lime-sulphur (1-75)* .. do.
9. *Colloidal sulphur (1-320)* .. do.

Seven control rows alternate with the above were very severely mildewed.

It is recommended that an application of sulphur dust be made as soon as the disease appears, preferably during warm and dry weather. Another application should be made several weeks later if the disease is seen to be spreading.

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A FRUIT ROT OF APPLES AND PEARS DUE TO A VARIETY OF PHYTOPHTHORA SYRINGAE.

BY L. OGILVIE.

Prevalence of the Disease.

During the autumn of 1929 a fruit rot of apples and pears somewhat resembling "brown rot" (due to *Monilia fructigena*) was very prevalent in the south-west of England. It was first observed on seedling apples and pears in the orchards at Long Ashton late in October, and was subsequently found on the majority of the wind-falls in the orchards. No fruits on the trees were diseased except the variety "Allington Pippin." In this case fruits on branches near the ground were affected.

Specimens of diseased fruits of many varieties were obtained from Somerset, Devonshire, Wiltshire and Herefordshire. The disease was also largely prevalent on the cider apples and perry pears sent to the Institute from the south of England and South Wales, all the samples being affected to the extent of about two per cent. of the fruits.

The disease was again prevalent in the autumn of 1930, to about the same extent, in the Long Ashton orchards. In certain of the cider apple samples sent in from Monmouthshire in 1930 no less than 30 per cent. of the fruits were affected.

Symptoms.

The symptoms on the apple fruits are light brown areas on the skin which resemble bruise marks but differ from these in the absence of any flattening of the contour of the fruit. Inoculations of the causative organism have shown that the colour of the affected areas varies greatly. Thus on "Allington Pippin" the colour is greyish brown and somewhat glassy, in the case of "Monarch" chestnut brown, and in the case of "Lane's Prince Albert" dark brown. In the last case the disease could be very easily confused with "brown rot."

In the interior of the fruit the affected area extends towards the core. The affected flesh has brown striations marking the course of the vessels and is of a rather tough consistency, not soft and pulpy as is often the case in fruit affected with "brown rot."

On pears the affected areas are dark brown in colour, the edge of the affected area being well defined. The affected flesh is darker brown than in the case of the apple, rather firm, and traversed by brown striations which mark the course of the vascular bundles.

The Causative Fungus.

If affected fruits are kept for a few days in a moist chamber, tufts of hyphae grow out from the lenticels, while cut surfaces become covered with a rich white mycelial growth. Sporangia are, however, sparingly produced. Affected pieces of fruits are seen under the microscope to be permeated by a hyaline, non-septate mycelium.

The organism in question grows slowly on solid media and was most easily isolated by placing pieces, taken from the interior of affected fruits, in slightly acidified 5% dextrose yeast water. The fungus grows out in two or three days at 25° C. and can then be transferred to solid media. The best medium for the growth of the fungus was found to be sterile carrot chunks. On these a white or brownish white growth of compact mycelium is produced which gives rise to rich woolly white aerial mycelium. On 5% potato dextrose agar a very profusely branched mycelium is produced, with occasional swellings covered with projecting hyphal knobs. The culture forms a rich fluffy white mycelial growth. On the following media growth was very poor or almost imperceptible:—malt extract agar, haricot bean agar, oatmeal agar, maize agar, steamed rice, steamed maize kernels and steamed potato plug. In the liquid medium (5% dextrose yeast water) an extreme branching is induced which gives rise to white clumps of hyphae.

I am indebted to Mr. S. F. Ashby for the following observations made by him on a pure culture of the fungus:

“Sporangia were formed in fair numbers after a month at room temperature on a mixture of Quaker oats agar and maize extract agar and more developed after transferring to water overnight. They were of the *P. Syringae* type with broad apex and no perceptible papilla, but appreciably larger and with a wider ratio than those recorded by Lafferty and Pethybridge (2) ($40 \times 27 \mu$). The measurements were:—

On the agar	— mean of 17	= $45.4 \times 28.3\mu$
	range	= $36-54 \times 22.8-30\mu$
	ratio	= 1.60
In water	— mean of 35	= $48.8 \times 28.5\mu$
	range	= $39-66 \times 24.5-33\mu$
	ratio	= 1.70



FIG. 1. Pear, seedling variety, affected with rot caused by
Phytophthora Syringae var.

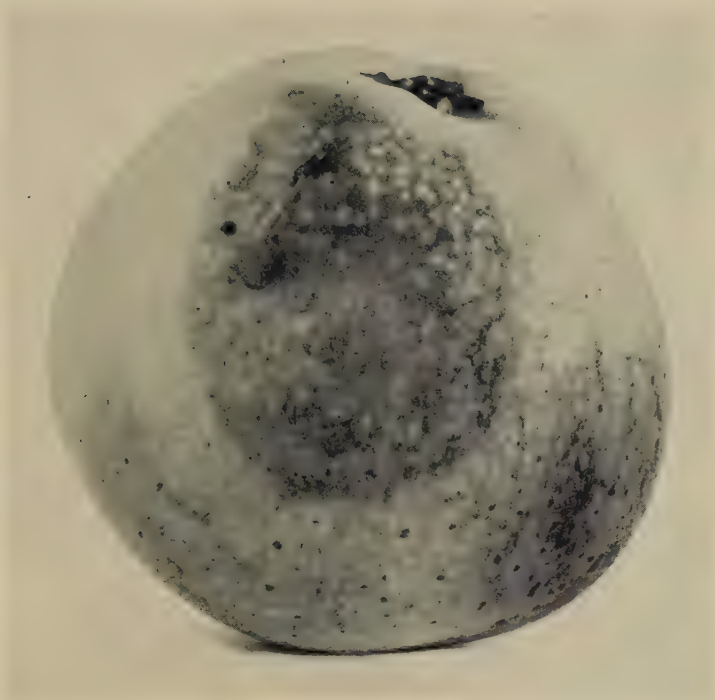


FIG. 2. Apple, "Allington Pippin," affected with rot caused by *Phytophthora Syringae* var.

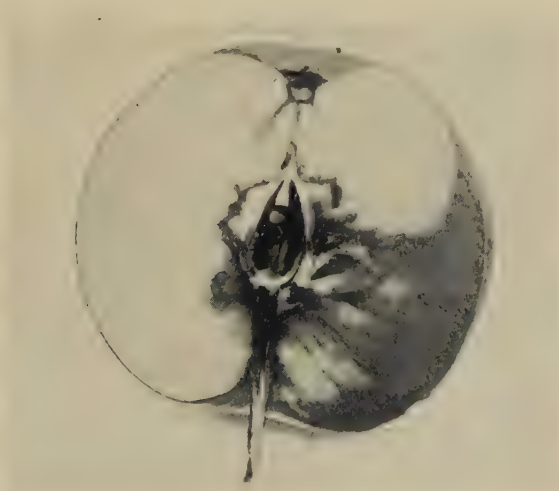


FIG. 3. Longitudinal section of affected apple.

In a plating on maize extract agar tuberculate enlargements of the hyphae were formed, quite similar to those figured by Rosenbaum for *P. Syringae*."

Ashby found abundance of mature sexual organs in the mummied apples. The antheridia were nearly all paragynous but several were amphigynous. The dimensions agree with those recorded by Lafferty and Pethybridge for *P. Syringae*, the oospores having a mean of about 24.5μ , with a range of 19— 29μ .

Oogonia and oospores were not found by the writer in cultures of the fungus, but C. E. Foister, who cultured material sent to him, found oospores in reasonable numbers in Quaker oat agar. Foister also found both paragynous and amphigynous antheridia in about equal numbers.

Ashby considers the *Phytophthora* in question to be a strain of *P. Syringae*, distinct however from the Irish strain of Lafferty and Pethybridge.

Previous References.

The *Phytophthora* rot of apples described by Lafferty and Pethybridge from Ireland was apparently not very prevalent, only two affected apples having been recorded. There have been many references to apple and pear fruit rots caused by species of *Phytophthora* both in Europe and America, but in all these instances the rot was attributed either to *P. Cactorum* or to its synonym *P. omnivora*. These references are given in the paper by Lafferty and Pethybridge and in a recent paper by Arnaud and Barthelet (1). Cultures of *Phytophthoras* associated with apple and pear rots were obtained by Lafferty and Pethybridge from Cheshunt, Herts., and from U.S.A. and Switzerland. These, however, were found to be definitely *P. Cactorum* and not *P. Syringae*.

It seems, therefore, that there are prevalent in England two *Phytophthora* fruit rots of apples and pears, caused by *P. Cactorum*, as described by Wormald in 1912 and 1915 (4), and by a strain of *P. Syringae*, as here recorded, the latter being very prevalent in the south-west.

In the Ministry of Agriculture's reports on fungus diseases there are references to a *Phytophthora* on apples in Sussex in 1917 and in Kent in 1919. In the 1920-21 report it is stated that *Phytophthora* "may be found occasionally causing wet rot of market supplies (possibly of French origin)." There are no references to the disease during 1922-24. Mr. D. W. Davies reported *Phytophthora* rot of "Lord Grosvenor" in Cardiganshire in September 1925. Since then he has observed it on "Newton Wonder." R. M. Nattrass,

in the Long Ashton report for 1926, reported a *Phytophthora* rot from the Bristol Province. Apples affected with a *Phytophthora* rot were also received from C. E. Foister, of Edinburgh, but attempts to isolate the fungus were unsuccessful.

Spread of the Disease and its Control.

Workers with the fruit rot caused by *P. Cactorum* proved that infection took place largely from the soil, and observations at Long Ashton indicated that this was also the case with *P. Syringae*. A layer of orchard soil was placed in sterilised crystallising dishes and apples of the variety "Bramley's Seedling," the skin of which had been surface sterilised by rubbing with methylated spirit and subsequently soaking in mercuric chloride 1 : 1000, were placed on the layer of soil. Sterilised water was then added to the depth of $\frac{1}{2}$ inch. After twelve days at laboratory temperature infection took place in two dishes so treated and the fungus was isolated from the infected fruits.

In the case of inoculations made by inserting pieces of mycelium under the skin of the fruit, discoloured lesions become apparent in four days at 17° C., and in a fortnight these reached a surface diameter of two inches and extended to the core of the fruit.

Sound fruits in contact with diseased ones become infected readily with the disease. Thus fruits of "Bramley's Seedling" and "Lane's Prince Albert" were surface sterilised and placed in contact with affected fruits in a crystallising dish which had been previously sterilised. The bottom of the crystallising dish was covered with sterile filter paper and sterilised water was added to the depth of $\frac{1}{2}$ inch. In nineteen days at 17° C. the surface sterilised fruits had developed the disease, and the fungus was re-isolated from these fruits.

Healthy and diseased pears were also placed in contact in trays in a fruit store at about 16° C. The healthy fruits became infected in less than a fortnight.

The disease also develops in cold storage in about a month.

It is thus evident that control of the disease is to be brought about by preventing the fruit from coming in contact with the soil and by culling out diseased fruits from the storage trays at frequent intervals.

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SPRAYING TRIALS AGAINST APPLE AND PEAR SCAB AT LONG ASHTON.

III. SEASON 1930.

BY R. W. MARSH.

The present paper is to be read in connection with the previous articles in this series, published by Mr. Maynard and the present writer, in the Long Ashton Annual Reports for 1928 (p. 112) and 1929 (p. 155). The continuation of spraying experiments and the highly successful control of scab obtained on the same plots for two years in succession led to the attempt in 1930 to establish the cumulative effect of scab control treatments. In order to determine this effect, certain varieties not highly susceptible to scab, on plots which had been practically clean in 1929, were either left unsprayed or given a light spraying programme. The scab-susceptible varieties were given two, or three, sprayings as in 1929.

Concerning spray damage, it was pointed out in 1929 that the variety Lane's Prince Albert could not safely be treated after blossoming with either sulphur-containing or copper-containing fungicides. It has been claimed in Nova Scotia that the damage caused to sulphur-sensitive varieties could be obviated by adding aluminium sulphate to the sulphur-containing spray. A trial of this mixture was therefore carried out on trees of Lane's Prince Albert at Long Ashton; this is described below.

Records of spray costs were made as in previous years on plots where the spraying was on a commercial scale. In addition, trials were made of the relative time taken to spray with guns and to spray with lances, other things being equal. Comparisons were also made of the cover obtained and the amount of damage resulting from these two systems of spraying.

A trial of Bordeaux mixture (one pre-blossom and one post-blossom spray) was made for the first time on the main block of pears in the Long Ashton plantations. In this block were representatives of 26 varieties of pear trees, giving the opportunity for making observations on spray damage as well as on scab control. A description of the pear plot follows:—

Plot 11a (5/6 acre).

This plot consists of bush pear trees planted as two-year-olds in autumn 1923. The trees stand 10 by 10ft. in 34 rows each of 11 trees. The planning of this plot is irregular, the varieties principally represented being :—Beurre Hardy (99 trees), Conference

(90), William's Bon Chretien (63), Fondante de Thirriot (44), and Josephine de Malines (44). Single specimens of some twenty-one other varieties are included in the plot.

SPRAYING PROGRAMME.

The apple plots used for spraying were Nos. 7*b*, 7*c*, 8*a* and 11 (described in 1928 and 1929 Reports). The complete scab control programme for 1930 is set out in Table I. Concerning this programme, it should be stated that plot 7*c* was required in addition for Pyrethrum trials against red spider: it could not therefore be treated with any sulphur-containing spray fluid. Two varieties in this plot (Lane and Worcester) showed such excellent control of scab in 1929 that they were left unsprayed in 1930. On Newton and Grieve a considerable amount of scab had been present in 1929, and these varieties were therefore allotted two pre-blossom and one post-blossom sprays. On Grieve the post-blossom application was used as a test of spray damage, some trees being treated with guns and some with lances. The Allingtons, which had 91.8 per cent. clean fruit in 1929, were given one pre- and one post-blossom spray: the Cox's were given a pre-blossom spray only since they could not be used for spray damage experiments.

On plot 7*b*, the Lanes were left unsprayed to judge of the cumulative effect of the 1928 and 1929 sprayings. The Worcesters received one pre-blossom and one post-blossom Bordeaux spray, comparing gun and lance application.

TABLE I.
SPRAYING PROGRAMME.

Plot.	Variety.	<i>Per cent. scab-free fruit in 1929.</i>		1930 Programme.	
				<i>Pre-blossom.</i>	<i>Post-blossom.</i>
7 <i>b</i>	Worcester	..	99.9	Bordeaux 4-10-50	Bordeaux 2-5-50
	Lane ..	..	100	No spray.	
7 <i>c</i>	Lane ..	..	100	No spray.	
	Worcester	..	99.6	ditto	
	Newton ..	..	83.7	Bordeaux 4-10-50 (twice)	Bordeaux 2-5-50
	Allington	..	91.8	Bordeaux 4-10-50	Bordeaux 2-5-50
	Grieve ..	..	56.2—99.8	Bordeaux 4-10-50 (twice)	Bordeaux 2-5-50
	Cox ..	..	88.8—94.2	Bordeaux 4-10-50	—
8 <i>a</i>	Allington	..	99.9	Lime-sulphur 1-60.	—
	Edward ..	..	100	ditto	—
11	Worcester	..	99.4	Sulphur dust	—
	Lane ..	..	99.5	ditto	
	Allington	..	99.4	ditto	
	Cox ..	..	91	ditto	
11 <i>a</i>	Pear varieties ..	..	No crop	Bordeaux 4-10-50	Bordeaux 2-5-50

The Allingtons and Edwards on plot 8a were allotted a single spray with 1 in 60 lime-sulphur, to test whether this treatment would be sufficient to maintain the high level of control obtained in 1929.

Plot 11 (young apples, six years planted) was given a single pre-blossom dusting with sulphur. The programme for plot 11a (pears) is referred to earlier.

The control trees available in 1930 comprised the row of Lanes in plot 9 used in previous years. Part of this row was used for the experiment with aluminium sulphate, and will be dealt with under that heading.

The trees of Grieve left unsprayed in 1929 showed abundant scabbed wood in the spring of 1930: occasional scabbed twigs were also found in the control row of Lanes, but the remaining apple plots sprayed were free.

PRE-BLOSSOM SPRAYS.

The first pre-blossom spray was applied on April 10th on the trees listed below:—

<i>Plot.</i>	<i>Variety.</i>	<i>Stage at time of Spraying.</i>		
7c	Grieve	..	..	Nearly green flower
	Allington	..	..	ditto
	Newton	..	..	Burst
	Cox	..	..	Nearly green flower
11a	Pear varieties..	..	..	Varying from burst to pre-flowering.

These plots were all sprayed as in 1929, using the power sprayer and moveable mains. Spray guns were employed throughout this series of applications except on Grieves.

The main pre-blossom application was carried out on April 28th and May 1st. The details are as follows:—

<i>Date.</i>	<i>Plot.</i>	<i>Variety.</i>	<i>Stage at time of Spraying.</i>		
28.4.30	7b	Worcester	..	..	Nearly pink
28.4.30	7c	Grieve	..	..	Pink
		Allington	..	..	Nearly pink
		Newton	..	..	Green flower
1.5.30	8a	Allington	..	..	Nearly pink
		Edward	..	..	Nearly green flower

This application was carried out as before, using spray guns, except on Grieves and on half of the Worcesters. (Further reference to this point will be made later under the heading of costs of spraying.) Plot 11 was dusted, using a hand machine, on May 5th.

Weather.

The first week of April was wet and stormy; the 10th was fair with a light N.E. wind. During the next fortnight rain fell on every day except two, and the temperature remained generally low. The last five days of the month were fine, with gradually increasing warmth, but there were northerly winds at over 20 m.p.h. on the 28th and 29th. The total rainfall for the month was 2.7 inches.

May opened with dry and sunny weather: the 5th was cloudy with 0.06 inches rain and a light northerly wind. Rain fell on every remaining day of the month except the 7th, 16th, 20th, 27th and 28th, but the falls were generally light. May 16th was sunny with a southerly wind at about 10 m.p.h. The total rainfall for the month was 1.45 inches.

POST-BLOSSOM SPRAY.

The post-blossom spray was carried out on May 16th on the pears and June 2nd on the apples. The only varieties sprayed were Worcesters (in 7b), Grieves, Allingtons and Newtons (in 7c), and the pear varieties in 11a. On Worcesters and Grieves a further comparison of gun and lance applications was made: the remainder of the spraying was carried out with guns as before.

Weather.

There was a light fall of rain on June 1st, but the 2nd was fair with a very light S.E. wind. An inch and a half of rain fell on the 23rd and 24th, but the remainder of the month was predominantly fine and dry, the total rainfall for June being 1.98 inches.

SPRAY DAMAGE.

The spray damage resulting from the post-blossom application was as follows:—

<i>Plot.</i>	<i>Variety.</i>	<i>Spray Fluid Employed.</i>	<i>Damage.</i>
7b	Worcester ..	Bordeaux 2-5-50 ..	Frequent russetting: occasional cracking
7c	Grieve ..	Bordeaux 2-5-50 ..	Widespread serious russetting and cracking

In both instances, the use of spray guns, as against the use of lances, did not appear to affect the amount of damage.

Use of Aluminium Sulphate in Relation to Spray Damage.

A small trial of a post-blossom application of a lime sulphur-aluminium sulphate mixture was made in the Long Ashton plantations on June 16th, using twenty trees of the sulphur-sensitive

variety Lane's Prince Albert. These trees were about 12 years planted, 8-9ft. high and 12-15ft. spread. With three exceptions they formed a single row, so that the spraying treatments could be carried out without any danger of spray drift. The trees had not been sprayed in the spring and, by mid-June, scab was beginning to appear on the leaves.

The trial was arranged as follows :—

Series A	..	..	Nine trees left unsprayed.
Series B	..	..	Five trees sprayed with 1 in 60 lime-sulphur.
Series C	..	..	Six trees sprayed with 1 in 60 lime-sulphur <i>plus</i> aluminium sulphate.

The aluminium sulphate was added to the diluted spray fluid at the recommended rate of 3½lb. to every gallon of lime-sulphur concentrate. This addition approximately doubled the cost of the spray fluid.

The sprays were applied with a headland sprayer and gun, at a pressure of 90lb. to the square inch. Approximately 1¾ gallons of spray fluid were used per tree. Spraying was done by the writer, to ensure uniform application as far as possible.

At the time of spraying the trees bore an abundant crop, from 500 to 1,200 fruits per tree. In the latter part of June, however, there was a very heavy drop from all the trees, accentuated by sawfly damage. In July it was noted that the trees of series B (sprayed with lime-sulphur) showed leaf scorching and leaf drop, and had lost practically all their fruits. In series C there was no leaf scorching, but the drop was obviously heavier than in series A. Scab continued to develop slowly during the rest of the summer on the unsprayed trees, but was not noted on the remainder.

During August and September the crop was further reduced by gales and the final counts, made on October 6th, resulted as follows :

TABLE II.
FRUITS ON TREE 6.10.30.

Series.	Treatment.	Number of trees.	Average Fruits per Tree.		
			Scab-free.	Scabbed.	Total.
A	Unsprayed	9	57	56	113
B	Sprayed with lime-sulphur 1 in 60	5	14	2	16
C	Sprayed with lime-sulphur <i>plus</i> aluminium sulphate ..	6	43	7	50

The quantity of fruit in Series B and C was too small for any deduction to be drawn concerning fungicidal effect : the indications

are, however, that the addition of aluminium sulphate was not prejudicial to the fungicidal effect of the lime sulphur. Concerning spray damage, the above results show markedly the loss caused on Lane's Prince Albert by the use of lime-sulphur alone as a post-blossom spray. The addition of aluminium sulphate would appear to mitigate this loss, but the average number of fruits remaining on the trees in Series C is seen to be considerably less than half the average number on the unsprayed trees. As far as can be judged from this experiment it appears that the success attained with this mixture in Canada is not likely to be repeated here. This conclusion is corroborated by an experiment made by Martin at Wye (Wye. Coll. Journ. 1930, p. 182), in which he found that the addition of aluminium sulphate to a lime sulphur spray did not diminish sulphur damage to gooseberries.

YIELD OF CLEAN AND OF SCABBED FRUIT.

Mature conidia of the apple scab fungus were first found on April 28th in a wood pustule on James Grieve. On May 12th, 20th and 26th, conidia were caught on vaselined slides exposed in the block of Grieve, but no ascospores were taken. Scab on the leaves was first noted on May 17th on an unsprayed pear tree. On the control trees of Lanes in plot 9, scab on the leaves was common by June, but only a few fruit infections took place in this month. During the wet weather of July and August, however, a large number of late infections on the fruit developed. On the trees of Lane in plot 7b, a little scab on the leaves and fruit was noted from June onwards. The Bramleys on this plot (unsprayed since 1928) also showed a few scabbed leaves.

It was noted that the scab pustules in the 1929 wood of Grieve remained active and continued to produce spores until September.

Counts were made principally in the late autumn while the fruit was passing over the grader. As previously, all fruits showing any scab whatsoever were counted as scabbed. The results are given in Table III.

TABLE III.
YIELD OF CLEAN AND OF SCABBED FRUIT.

Plot.	Variety.	Spray Treatment.	Total Fruits.	Scabbed Fruits.	Per cent. Scabbed.	Notes.
7b	Worcester .. Lane ..	Bordeaux and Bordeaux .. — ..	13,081 .. 14,090 ..	7 .. 658 ..	0.05 .. 4.7 ..	Recorded 17.10.30 Scab-free in 1929
7c	Grieve .. Newton .. Allington .. Cox ..	Bordeaux three times .. ditto .. ditto .. Bordeaux once ..	4,688 .. 320 .. 3,460 .. 1,781 ..	0 .. 0 .. 0 .. 0 ..	— .. — .. — .. — ..	
8a	Allington .. Edward ..	Lime-sulphur once .. ditto ..	26,555 .. 2,730 ..	519 .. 0 ..	1.96 .. — ..	Recorded 21.11.30
11	Allington .. Worcester .. Cox ..	Sulphur dust .. ditto .. ditto ..	1,108 .. 504 .. 1,141 ..	0 .. 0 .. 0 ..	— .. — .. — ..	
11a	Pear varieties ..	Bordeaux and Bordeaux ..	2,184 ..	32 ..	1.5 ..	
9	Lane ..	Control—No Spray ..	1,019 ..	505 ..	49.5 ..	52% scabbed in 1929

COSTS OF SPRAYING.

The full costs of spraying are shown at the end of this paper for plots 8a and 11a only, since the remainder of the spraying was carried out on comparatively small blocks of trees. The trials of the relative time taken to spray with guns and with lances were made in plots 7b and 7c, and the results obtained were as follows :—

<i>Date.</i>	<i>Plot.</i>	<i>Variety.</i>	<i>No. of trees.</i>		<i>How sprayed.</i>	<i>Total time required.</i>
29.4.30	7b	Worcester ..	..	48	Gun	64 mins.
do.	do.	do. ..	..	48	Lance	96 mins.
2.6.30	7b	do. ..	..	48	Gun	54 mins.
do.	do.	do. ..	..	48	Lance	84 mins.
2.6.30	7c	Grieve ..	..	10	Gun	20 mins.
do.	do.	do. ..	..	40	Lance	170 mins.

Each pair of results recorded above was obtained by working the guns and lances simultaneously off the power sprayer. It is seen that the time taken for spraying with lances is from one and a half to twice as great as that required to cover a comparable block of trees using guns.

GENERAL REVIEW.

The season under discussion was more favourable to scab attacks than 1928 or 1929, so that examples of freedom from this disease in 1930 were not likely to be the result of weather conditions. Taking this into account, the indications of the cumulative effect of scab control measures at Long Ashton are very striking. For instance, the 96 trees of Lane's Prince Albert in plot 7b, although not sprayed in 1930, gave 95.3 per cent. of scab-free fruit. Again, the acre of Allingtons on plot 8a gave 98 per cent. of clean fruit following a single spraying with lime-sulphur at 1 in 60. It is believed that this high measure of control results from the fact that these trees were almost freed from scab in 1928 and were maintained completely free in 1929. In consequence, no opportunity was provided for wood infections during 1929, and the source of a spring outbreak of scab was therefore eliminated.

On the Newtons and Grieves of plot 7c, where scab attack had been allowed to develop in 1929, the application of two pre-blossom and one post-blossom sprays resulted in completely scab-free crops in 1930. On the pear varieties, one pre-blossom and one post-blossom application, using Bordeaux mixture, gave 98.5 per cent. clean fruit without causing injury.

The experiment on spray damage showed that the addition of aluminium sulphate to lime-sulphur for use on Lane's Prince Albert proved unsatisfactory. The fruit drop was lessened by the use of the mixture but not obviated. The only safe method of controlling scab on Lane's Prince Albert appears to be by carrying out all spraying before the blossoming stage. On Worcester Pearmain, russetting was noted following a post-blossom spray with half-strength Bordeaux, although this application had been made on the same trees in 1928 with practically no ill-effect. To ensure safety with Worcesters it therefore appears necessary to use 1 in 60 lime-sulphur for the post-blossom application. No spray damage due to Bordeaux mixture was noted on the pear varieties, but further trials on this point are required before definite recommendations can be made.

The figures for costs on plot 8a are little different from the comparable data for the same plot in 1929. On the pear plot, the combined cost of two sprayings on trees seven years planted amounts to about 1½d. per tree. The comparisons between spraying with lances and spraying with guns show that the former is a considerably slower process, and it was found, in addition, that lance spraying gave a poor cover in windy weather. As there was no increase in spray damage following the use of guns, the saving in time obtained appears amply sufficient to justify their use in power spraying.

SUMMARY.

1. The continuation of scab control experiments at Long Ashton for the third year in succession has afforded striking evidence of the cumulative effect of spraying against scab.

2. The addition of aluminium sulphate to a lime-sulphur spray does not obviate sulphur damage to the variety Lane's Prince Albert.

3. An example of Bordeaux injury to the fruit of Worcester Pearmain is recorded.

4. The use of spray guns with a power outfit effects a saving of time of 33-50 per cent. when compared with the use of lances. Spraying with guns caused no increase in spray damage.

5. Excellent control of scab on pears was obtained by two sprayings with Bordeaux mixture—one before and one after flowering.

COSTS OF SPRAY

Plot	No. of Trees	Dates	Spray Fluid	MATERIALS									
				Substance	Amt.	Cost	Sub-stance	Amt.	Cost	Water	Total Cost of Materials	Cost per Tree	Gall. per Tree
8a	338	1.5.30	Lime-Sulphur 1-60	Lime-Sulphur concentrate	15 gall.	22/6	—	—	—	900 gall.	22/6	¾d.	2.7
*11a	374 pears	11.4.30	Bordeaux 4-10-50	Copper Sulphate	24 lb.	8/-	Lime	60 lb.	3/-	300 gall.	11/-	¾d.	0.8
Do.	Do.	16.5.30	Bordeaux 2.5.50	Copper Sulphate	16 lb.	5/4	Lime	40 lb.	2/-	400 gall.	7/4	¾d.	1.1

* REMARKS.—Ground very soft on 11.4.30. Pipes all carried to plot by hand.

SUMMARY OF

8a. £1 14 10
 = 1½d. per tree.
 = 17/5 per acre.

APPLICATIONS.

LABOUR							TRANSPORT		Total Cost of Labour Materials and Trans- port	Cost of Water- carting and Waste Time (Deduct)	Nett Cost	Cost per Tree
Man-Nozzle Hours	Attendant Hours	Hours Laying-out	Hours Waste Time	Horseman Hours	Total Man-Hours	Total Labour Cost at 10d. Hr.	Horse					
							Hrs.	Cost				
8½	5½	1	1	5½	21½	17/9	5½	5/6	£ s. d. 2 5 9	10/11	£ s. d. 1 14 10	1½d.
5½	2½	4	3½	6	21½	18/2	6	6/-	1 15 2	13/9	1 1 5	¾d.
4	3	1	1½	3	12½	10/5	3	3/-	1 0 9	6/9	14 0	¾d.

NETT COSTS

11a. Pre £1 1 5
Post 14 0

£1 15 5 = 1½d. per tree.
= £2 2 6 per acre.

APPLE SCAB CONTROL IN THE BRISTOL PROVINCE: FIELD TRIALS, 1930.*

BY R. W. MARSH.

INTRODUCTORY.

In spraying trials against apple scab carried out in the Long Ashton plantations in the past three years, excellent control has consistently been obtained by spray applications terminating at or before the petal fall stage. For the 1930 season it was decided to test this method of control more widely by making field trials in commercial plantations in Somerset, Worcestershire and Herefordshire. During the late summer and autumn of 1929 four centres were chosen for the spraying trials of 1930: these centres will be referred to as Bridgwater, Yeovil, Hereford and Malvern. The chief motive in choosing the Bridgwater, Yeovil and Hereford orchards was that the crops at these centres were completely ruined by scab in 1929. The Malvern plantation was chosen in order to repeat a trial at this centre which had on a previous occasion been spoilt by capsid attack. The four centres chosen were alike in being primarily laid out for the production of dessert apples, but in other respects they were very diverse, including examples of grass orchards and plantations, of trees of varying ages, of orchards well-equipped for spraying and those poorly equipped. Because of this diversity, each centre will be described individually in a subsequent section.

SOURCE OF SCAB INFECTION IN THE SPRING.

The location of the spraying trials in commercial plantations made the provision of large blocks of control trees not feasible. In each centre, however, a small group of trees was left unsprayed, so that some indication of the normal intensity of scab attack during the year could be obtained. In addition to taking the usual field observations on the spread of the disease, the attempt was made to determine the date at which infective material of the scab fungus could first be detected in the air round the trees and

* Abridged account: the full paper appeared in *The Journal of Pomology and Horticultural Science*. Vol. IX, No. 1, 1931. Reprinted by the kind permission of the Editors.

the form in which it was present. Two possibilities existed—the infective material present in the spring might either be ascospores from overwintered leaves or conidia from wood pustules. These two types of spore are easily distinguishable microscopically, but the conidia from the wood are the same as those produced later on the leaves and fruit. It followed that only those conidia present in the early stages of the unfolding of the leaf could be considered definitely as having come from the wood pustules, since at that period there would not have been time for conidia-bearing pustules to form on the young leaves. The attempts to record the number and type of spores present in the air were therefore confined (with one exception) to the period of approximately a month after bud-break.

The method of recording the spore content of the air was by exposing ordinary microscope slides (3 x 1 in.) of which both sides had been thinly coated with vaseline. These slides were suspended vertically in various directions from wooden clips attached to the branches of unsprayed trees at differing heights above the ground. The trees employed were those in the grass orchards at the Yeovil and Hereford centres and in the plantation at Bridgwater. After several days' exposure the slides were brought in to the laboratory, where measured areas of both surfaces were examined at a magnification of approximately 400 diameters, and the number of scab conidia and ascospores noted. From several such readings, the average deposition of spores per square inch of surface for the period of exposure was obtained.

SPRAY PROGRAMMES.

The general programme of spraying proposed for each trial was that which had proved so successful at Long Ashton, namely, two pre-blossom and one post-blossom sprays. This programme was carried out (except at Malvern) on all the trees of the badly-scabbing varieties (Worcester, Grieve, Cox) throughout the trials. However, on trees of Lane and Newton, which are less susceptible to scab but very sensitive to spray damage, pre-blossom applications only were given. The relation of the time of spraying to the stage of development of the blossom buds was recorded whenever possible. An explanation of the nomenclature used for the blossom bud stages is given by the diagrams in Fig. 1.

WEATHER.

As weather is an important factor in determining the intensity of scab attack, a brief summary of the 1930 conditions will be given. A very mild and wet winter was followed by a persistently

dull cool spring. From the middle of March until the end of April was a showery, cold and sunless period except for a short mild spell at the end of March. The last few days of April and the first of May were fine, but afterwards dull cool weather set in again with frequent showers but no heavy falls. At the end of May the temperature rose, and June was generally a fine and dry month with a short period of heavy rain in the third week. July was fair in the first fortnight, but later the cool unsettled showery conditions returned and continued until the end of August when there was a week of dry and very hot weather. September, after a fair beginning, was dull and rainy with gales and cold winds at the end of the month.

One result of the cold spring was that the opening of the buds in 1930 was very much later than normal, so that the blossoms entirely escaped frost damage. The percentage of setting was generally low, but the quantity of blossom was so great that, with a few exceptions, the varieties included in the trials carried a fair crop. Conditions for spraying were good in June, but earlier the number of wet days severely limited the time available for spray treatments. Infection by the scab fungus was favoured by the weather in May but checked by the dry period in June and early July. After mid-July, however, the conditions for rapid spread of the fungus were highly favourable, and late attacks on fruit were general throughout the province.

METHOD OF RECORDING RESULTS.

In recording the results of the trials it was necessary, because of the amount of material involved to take samples which were a relatively small proportion of the total crop. In order to make the results as nearly comparable as possible, all the counts were carried out during the last week of August, and the samples of each variety were collected from several trees in different parts of the appropriate blocks. The samples were then carefully graded on the lines introduced by M. H. Moore at East Malling. Each apple on examination was placed in one of five categories dependent on the total area of scab infection, these five categories being as follows (see Fig. 2):—

- | | |
|--------------|--|
| Category I | .. Entirely free from scab. |
| Category II | .. Scabbed area not exceeding a total of $\frac{1}{4}$ inch square. |
| Category III | .. Scabbed area exceeding a total of $\frac{1}{4}$ inch square but not exceeding a total of $\frac{1}{2}$ inch square. |

- Category IV .. Scabbed area exceeding a total of $\frac{1}{2}$ inch square but not exceeding a total of 1 inch square.
- Category V .. Scabbed area exceeding a total of 1 inch square.

DETAILS OF INDIVIDUAL SPRAYING TRIALS.

For each centre the following details are listed in the order given :—

- Description of orchard.
- Previous scab attack.
- Spraying equipment available.
- Spore deposition (in unsprayed blocks).
- Spray applications.
- Development of scab during summer.
- Yield of clean and of scabbed fruit.
- Data on the costs of spraying are given in an appendix.

In many instances the records are incomplete, due principally to the distance of the centres from the Research Station and the consequent difficulty of making frequent visits.

A summary of the spray trials on the trees of Worcester Pearmain at Bridgwater, Yeovil and Hereford is presented graphically in Fig. 3. The results of the final counts are illustrated in Fig. 4.

CENTRE 1—BRIDGWATER.

Description of Orchard. Approx. 3,000 bush apples, cultivated, 9ft. height, 8ft. spread, planted 15 by 15ft. Varieties—Worcester, Cox, Newton, Lane, Bramley. Area—15 acres.

Previous Scab Attack. In 1929 serious on Cox and Worcester ; scabbed wood plentiful in spring 1930 : light attack on Lane and Newton.

Spraying Equipment. $3\frac{1}{2}$ h.p. outfit with four lances.

Spore Deposition. April 15 to 26—None. April 30 to May 15—Average concentration of 8 conidia per square inch.

Spray Applications.

Variety.	Stage.	Date.	Spray employed.	Remarks.
Cox	Green flower	April 16	Lime-sulphur 1 in 30	
Worcester	" "	April 24	" "	
Cox	Pink	} April 29 { and 30 {	Lime-sulphur 1 in 40	
Lane	"		" "	
Newton	"		" "	
Worcester	"	May 2	" "	
Cox	Petal fall	June 3	Lime-sulphur 1 in 66	Very slight leaf tip scorching.
Worcester	" "	June 4	Lime-sulphur 1 in 100	

Development of Scab during Summer. Scab was first recorded on May 22nd, at which date it could easily be found on the unsprayed trees, an occasional blossom truss being heavily attacked. On the sprayed trees no scab was found at this time. By June 6th, the control trees each showed 20-30 scabbed leaves, while of 40 sprayed trees (Cox and Worcester) examined at random, 37 were perfectly clean, 2 showed one scabbed leaf and the other showed three scabbed leaves. At this date the crop on the control trees was much lighter than the average on the corresponding sprayed Cox's.

Yield of Clean and of Scabbed Fruit. Counts were made on August 27th on Cox and Worcester only, the Lanes having failed to crop. The yield from the four control trees of Cox was so small that the total number of fruits did not reach 100. For this reason the "percentages" below relating to the control trees are given in brackets. The sprayed Cox's carried a fair crop, amounting to about 12 tons in all: the Worcesters carried a good crop totalling approximately 14 tons. Samples were taken from the young orchard only, but a rough count showed that the results obtained in the old orchard were of the same order.

TABLE 1. RESULTS AT BRIDGWATER.

Variety—Cox.					
<i>Sprayed.</i>			<i>Unsprayed.</i>		
Scab Category		No. Percentage.	No. Percentage.		
I	..	150 97%	36	(55%)	
II	..	4 2%	23	(35%)	
III	..	1 1%	7	(10%)	
IV	..	0 —	0	—	
V	..	0 —	0	—	
Variety—Worcester.					
Scab Category		No. Percentage.			
I	..	134 98%			
II	..	3 2%			
III	..	0 —			
IV	..	0 —			
V	..	0 —			

CENTRE 2—YEOVIL.

Description of Orchard. 522 bush apples in grass, 8ft. height, 6ft. spread, planted at 10 by 10ft. Varieties—Worcester, Cox, King of the Pippins. Area—1½ acres.

Previous Scab Attack. In 1929, very serious on all varieties: badly-scabbed wood abundant in spring 1930.

Spraying Equipment. Barrow pump and two lances.

Spore Deposition. April 4 to 12—None. April 16 to May 5—Average concentration of 53 conidia per square inch.

Spray Applications.

Variety.	Stage.	Date.	Spray employed.	Remarks.
Cox	Burst	} April 4 and 10 {	Lime-sulphur	Application premature.
King	"		1 in 30	
Worcester	"	April 14	" "	"
Cox	Pink	May 2	" "	"
King	"	"	" "	"
Worcester	"	May 5	" "	"
Cox	Petal fall	May 29	Lime-sulphur	
			1 in 80	
King	" "	"	Lime-sulphur	
			1 in 60	
Worcester	" "	"	" "	"

Development of Scab during Summer. On May 22 the unsprayed trees were found to have leaves of occasional blossom trusses badly scabbed. No scab was found on the sprayed trees on this date, but by June 12 it was appearing on the leaves of the sprayed Worcesters and Cox's. It was noted that the grass in the orchard was not cut until June 5th, by which time it was covering the lower branches of many of the trees. On July 7th, the leaves of the control trees were literally black with scab, while the crop was small and about 30 per cent. marked with scab. The sprayed trees at this date showed approximately 10 per cent. of the fruit scabbed.

Yield of Clean and of Scabbed Fruit. Counts were made on August 26th on the Worcesters only, there being practically no crop on the Cox's and Kings. The total yield of Worcesters was approximately 2·tons.

TABLE II. RESULTS AT YEovil.

Variety—Worcester.

Scab Category	I ..	II ..	III ..	IV ..	V ..	<i>Sprayed.</i>		<i>Unsprayed.</i>	
						No.	Percentage.	No.	Percentage.
						273	65%	57	37%
						137	32%	74	48%
						13	3%	19	12%
						0	—	2	2%
						0	—	1	1%

CENTRE 3—HEREFORD.

Description of Orchard. Approx. 3,600 bush apples in grass, 8 to 12ft. height, 6 to 15ft. spread, planted 12 by 12ft. The lower part of the orchard consisted of 3 acres (900 trees) of Worcesters and Lanes alternating: the Lanes in particular had made vigorous growth and the branches of adjacent trees were commonly interlaced. This block will be referred to below as the "Lower Orchard." The remainder ("Upper Orchard") consisted first of 200 Newtons,

followed by 6 acres (1,800 trees) of Worcesters and Grieves alternating. The Grieves had had much wood cut out following canker attack, so that this part of the orchard was much less dense than the Lower Orchard. The top of the slope carried another 3 acres of Worcesters and Lanes alternating, this block being again relatively open.

Previous Scab Attack. In 1929 very serious on Grieve, Worcester and Lane: abundant scabbed wood present in spring 1930.

Spraying Equipment. Headland sprayer and two guns, also two knapsack sprayers.

Spore Deposition. April 25 to May 8—Average concentration of 9 conidia per square inch. May 19 to June 3—Average concentration of 132 conidia per square inch. (N.B.—By the end of this period, scab spores were being produced by secondary infections on the young leaves.)

Spray Applications.

<i>Variety.</i>	<i>Stage.</i>	<i>Date.</i>	<i>Spray employed.</i>	<i>Remarks.</i>
Worcester ..	Burst	April 22	Bordeaux 4-10-50	Premature application, especially on Worcester.
Grieve ..	Nearly green flower.	to	" "	
Lane ..	"	28	" "	
Worcester ..	Late pink stage.	May 16	" "	
Grieve ..	"	to	" "	
Lane ..	"	"	" "	
Newton ..	"	24	" "	
Worcester ..	Petal fall	June 4	Lime-sulphur 1 in 60	Slight defoliation and faint russetting.
Grieve ..	" "	6	" "	

Development of Scab during Summer. The first examination for scab was made on June 3, on which date the unsprayed Worcesters showed about 12 badly-scabbed leaves per tree. A month later, the sprayed trees were still completely free from scab, but on the unsprayed Worcesters, of 100 fruits counted, 52 were seriously scabbed. At this date (July 3) the unsprayed Lanes showed abundant scabbed foliage but no scabbed fruit. The further development of a heavy scab attack on the crop of these trees is shown by the counts below.

Yield of Clean and of Scabbed Fruit. Final records were taken on August 29, and, owing to the marked differences observed between the results in the Upper and the Lower Orchards, these are shown separately.

BLOSSOM STAGES.



" SWELLING "



" BURSTING "



" BURST "



"GREEN FLOWER"



" PINK "

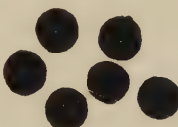


" PETAL FALL "

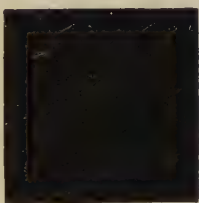
Figure 1.

CATEGORY I :— Maximum total area
of scab permitted — **NONE**

CATEGORY II :— Maximum total area
of scab permitted — **QUARTER-INCH SQUARE**
i.e.  equivalent to  or  etc

CATEGORY III :— Maximum total area
of scab permitted — **HALF - INCH SQUARE**
i.e.  equivalent to  or  etc

CATEGORY IV :— Maximum total area
of scab permitted — **ONE INCH SQUARE**

i.e.  equivalent
to 

or  etc

CATEGORY V
NO MAXIMUM

Figure 2

SUMMARY OF SPRAYING TRIALS ON VARIETY WORCESTER PEARMAIN AT BRIDGWATER, YEOVIL AND HEREFORD.

Symbols used for blossom stages --

 Swelling

 - Burst

 - Green Flower

 - Pink

 Full blossom

(for other explanations see text)

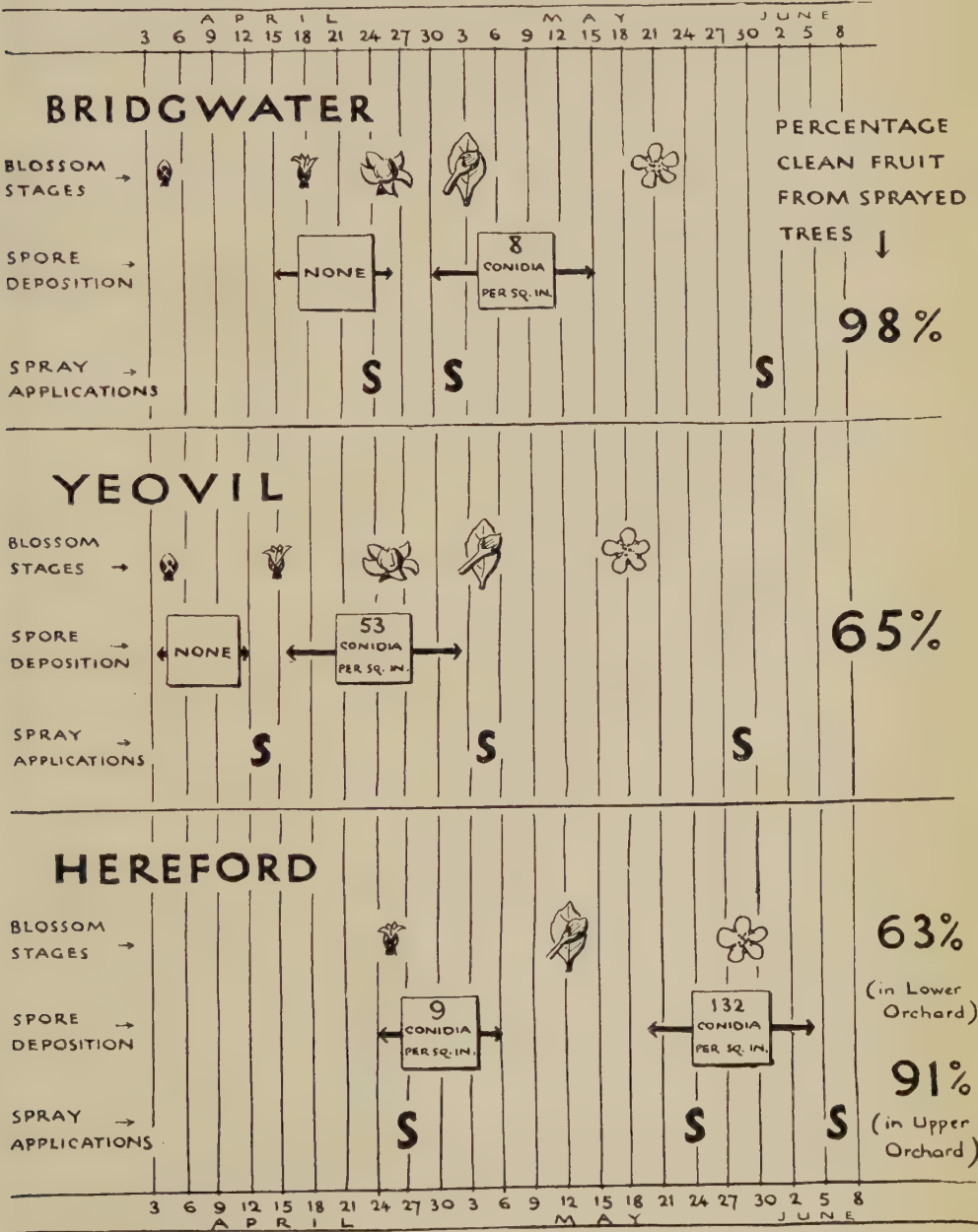
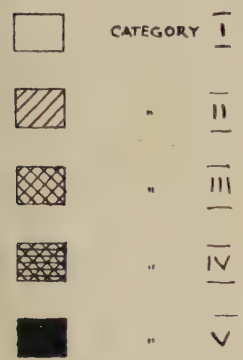


Figure 3

RESULTS OF SPRAYING TRIALS.

DIAGRAMS REPRESENTING AMOUNT OF SCAB INFECTION AT PICKING T

KEY



FOR DEFINITION
OF CATEGORIES
SEE FIGURE 2.

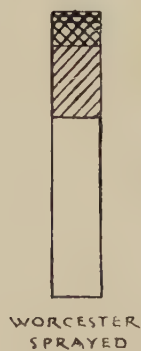
Centre 1
BRIDGWATER
(17 ACRES)



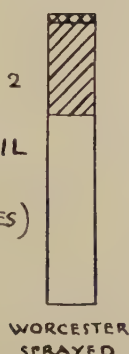
Centre 3a
HEREFORD
(UPPER ORCHARD
10 ACRES)



Centre 3b
HEREFORD
(LOWER ORCHARD
3 ACRES)



Centre 2
YEOVIL
(2 ACRES)



Centre 4
MALVERN
(1 ACRE)

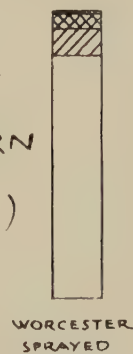


TABLE IIIA. RESULTS AT HEREFORD (UPPER ORCHARD).

Variety :		Worcester. Sprayed.		Grieve. Sprayed.		Lane. Sprayed.	
		No.	Percentage.	No.	Percentage.	No.	Percentage.
Scab Category	I	137	91%	303	96%	300	98%
	II	11	7%	12	4%	4	1%
	III	2	1%	0	—	4	1%
	IV	1	1%	0	—	0	—
	V	0	—	0	—	0	—

TABLE IIIB. RESULTS AT HEREFORD (LOWER ORCHARD).

Variety—Worcester.

		Sprayed.		Unsprayed.	
		No.	Percentage.	No.	Percentage.
Scab Category	I	82	63%	0	0%
	II	32	25%	8	8%
	III	13	9%	22	21%
	IV	3	3%	55	54%
	V	0	—	17	17%

Variety—Lane.

Scab Category	I	122	86%	41	29%
	II	13	9%	43	30%
	III	5	4%	45	31%
	IV	1	1%	12	9%
	V	0	—	1	1%

CENTRE 4—MALVERN.

Description of Orchard. 133 half-standard apples, cultivated, 12ft. height, 15ft. spread, planted on triangular system at 18ft. intervals. Variety Worcester. Area—1 acre.

Previous Scab Attack. In 1929 two Bordeaux sprays applied : 5% of crop scabbed. Very little scabbed wood present in spring 1930.

Spraying Equipment. 4 h.p. sprayer and four lances.

Spore Deposition. No records.

Spray Applications.

Variety.	Stage.	Date.	Spray employed.	Remarks.
Worcester	Burst	April 24	Bordeaux 4-8-50	Premature application.
„	Petal fall	June 9	Bordeaux 2-4-50	Occasional russetting at stalk end.

Development of Scab during Summer. An inspection on June 3 revealed no scab either on the controls or on the sprayed block. By July 2, however, scab was easily noticeable on the unsprayed Worcesters, while the sprayed block showed only one or two scabbed

fruits per tree. A count made on August 2 showed that 39% of the fruits on the control trees were scabbed, while only 5% of the fruits on the sprayed trees were scabbed.

Yield of Clean and of Scabbed Fruit. The final counts, taken on a good crop on August 28, showed the following results:—

TABLE IV. RESULTS AT MALVERN.

Variety—Worcester.					
Scab Category		Sprayed.		Unsprayed.	
		No.	Percentage.	No.	Percentage.
I	..	273	84%	40	19%
II	..	30	9%	51	24%
III	..	21	6%	58	28%
IV	..	2	1%	51	24%
V	..	0	—	10	5%

DISCUSSION.

The spraying programmes recommended proved quite practicable on a commercial scale and were carried out without serious difficulty although the spring was unusually showery. The results obtained were highly satisfactory at Bridgwater and in the Hereford Upper Orchard, *i.e.*, on a total of approximately 25 acres of Worcester, Cox, Grieve, Lane and Newton. From this acreage, in spite of a wet summer, the crop obtained was from 91 to 98% entirely free from scab. In the remaining portions of the trials—3 acres of Worcesters and Lanes in the Hereford Lower Orchard and 1/3rd acre of Worcesters at Yeovil—the results did not attain the same standard, but, considering the intensity of the scab attack in these areas, the effectiveness of the spray treatment was striking. Thus, at Yeovil, the unsprayed Worcesters were 37 per cent. scab-free, the sprayed 65 per cent. In the Hereford Lower Orchard the unsprayed Worcesters had no scab-free fruits; the sprayed had 63 per cent. The reason for the heavy scab attack at Hereford lay undoubtedly in the fact that the dense interlacing trees in the Lower Orchard provided conditions highly favourable to the fungus; at Yeovil, the long grass may have acted in a similar way. The possible relation of the time of spraying to the progress of infection at these centres is dealt with below.

The results of the experiments on spore deposition were rather surprising. It was expected that both overwintered leaves and scabbed twigs would be found acting as sources of infection but, during April and May, the only source of scab infection demonstrated was the pustules on the wood. A total of over 500 conidia was counted at different times on portions of the various slides exposed, but not a single ascospore was recorded on any slide.

In considering this result it must be borne in mind that the technique employed may have favoured the retention and the visibility of the conidia more than the ascospores and, again, that the winter of 1929—30 was extremely favourable to the complete destruction of fallen leaves. Nevertheless it appears that the hypotheses, based on the work of Keitt and others in the U.S.A., concerning the importance of infection from the overwintered leaves, ought not to be accepted for this country without further examination. Additional evidence pointing to the importance of scabbed wood as a source of primary infection in the spring has frequently been obtained during the 1930 season by noting the proximity of the first-scabbed leaves to active scab pustules on the twigs.

The time at which conidia were first caught on the slides varied in the different plantations. At Bridgwater none were caught until the fortnight April 30—May 15. At this centre the buds of Worcester were at the pink stage on May 3rd. At Yeovil, where the dates for the different stages of bud development were approximately the same as at Bridgwater, no conidia were caught before April 12, but 53 conidia per square inch were recorded in the period April 16—May 5. At Hereford, where the trees were about ten days later, 9 conidia per square inch were caught between April 25 and May 8. Thus, at Yeovil and Hereford, the deposition of conidia was well marked during the fortnight *before* the buds reached the pink stage, but in none of the centres was there any record of deposition of conidia until after the "burst" stage. The recommendation to give a first spraying at or about the green flower stage thus appears to be justified. If spraying is done before this stage, very few or no conidia are falling on to the young leaves, and the amount of the leaf surface exposed to the spray is very small. As the leaves expand still further, the tips only remain protected by the spray and the rest of the leaf is left vulnerable to infection until the time that the second spray is applied.

Turning to the results of the 1930 trials (and see Fig. 3) it will be noted that at the Yeovil and Hereford centres the first sprayings were applied at approximately the "burst" stage on Worcester (although at the correct stage for the other varieties). In the Upper Orchard at Hereford, where the trees were not crowded and the conditions for scab development therefore not so favourable, this too-early spraying was not markedly prejudicial to scab control. But where conditions for scab infection were more favourable, as in the Hereford Lower Orchard and at Yeovil, the long gap between the first and second spraying of the Worcesters gave the opportunity for early leaf infections to occur. In the

wet period from mid-July onwards infections from the leaf pustules thus initiated had an excellent opportunity for passing on to the fruit.

The trial at Bridgwater was not strictly comparable with those at Yeovil and in the Hereford Lower Orchard, since the records of spore deposition and of the infection of the control trees show that the intensity of scab attack was here much lower. But it is probably not solely due to this fact that, at this centre, where the times of application were strictly at the green flower, pink and petal fall stages, the results obtained were uniformly excellent.

The Malvern trial has not hitherto been considered and stands in a class by itself since this was the one centre at which scab had been successfully controlled in the previous year. In the writer's opinion it was this 1929 spraying, more than the premature first spray of 1930, which, by eliminating scabbed wood, kept the leaves clean up to blossom time. Where trees have been practically freed from scab in one year it is possible to take considerable liberties with the spraying programme in the following year and still obtain satisfactory results.

The costs of spraying will not be materially different whether the bulk of the spraying is done after blossoming or before, but the question of sparing the labour is frequently more acute after midsummer. The possibility of completing the scab control programme by June is particularly attractive in fruit plantations where the acreage is made up not only of apples but also of soft fruit. For such plantations, labour for scab spraying is rarely available after the commencement of strawberry picking. But the ability to carry out a scab control programme in the time between the green flower and the petal fall stages depends, where the apple acreage is large, upon making the fullest use of favourable weather periods for scab spraying. Insufficient spraying equipment, or the necessity for applying an additional insecticidal wash in the spring are the two factors most liable to upset a scab spraying programme. The degree of control of insect pests obtained during the winter is, because of its effect on the time available for spring spraying, a factor of considerable importance in scab control.

SUMMARY.

The possibility of controlling apple scab by two pre-blossom and one post-blossom sprays was examined by means of field trials in Somerset, Worcestershire and Herefordshire.

Excellent control was obtained when sprays were applied at the "green flower," "pink," and "petal fall" stages. Where the

first spray was applied before the "green flower" stage the control was less effective.

It was shown by exposing vaselined slides that conidia from wood pustules were present in the air around trees of Cox and Worcester at the time that the first leaves were unfolding. No ascospores (from overwintered leaves) were caught on these slides. The relation of the time of spraying to the presence of infecting spores is considered.

The costs of the spray treatments are given in certain instances and the practical advantages of early spraying are discussed.

Diagrams are given illustrating a method of estimating scab damage and a nomenclature for blossom bud stages.

APPENDIX—SPRAYING COSTS.

Data concerning spraying costs were obtained for the following spray applications :—

Centre 2.	Yeovil	..	Both pre-blossom applications.
Centre 3.	Hereford	..	First pre-blossom application.
Centre 4.	Malvern	..	One pre-blossom and one post-blossom application.

For ease of comparison, the figures are presented in the same form as that given by Maynard in Long Ashton Annual Report 1929, p. 175.

COSTS FROM 1930 FIELD TRIALS.

Date.	Centre.	Machine.	Nozzles.	Spray Fluid.	Galls.	Cost of Materials	Spraying Man-Hours.	Attendant Man-Hours.	Layout Man-Hours.	Labour Cost (at 10d. Hr.)	Total Nett Cost	Water Cart-ing Cost.	Waste Time	Gross Cost	Nett per Tree	Nett per Acre	REMARKS.
April 4.10.15	Yeovil	Barrow Pump	2 Lances	L.S. 1-30	255	£ s. d. 0 12 9	19	9½	2½	£ s. d. 1 5 10	£ s. d. 1 18 7	s. d. 6 5	s. d. 2 1	£ s. d. 2 7 1	d. 0.9	£ s. d. 1 11 0	
May 4 ..	do.	do.	do.	do.	270	0 13 6	16	8	1½	1 1 3	1 14 9	4 7 1	3	2 0 7	0.8	1 7 8	
April 22 to 26 and 28.	Hereford	Headland Pump and 2 Knapsacks	2 Guns 2 Lances	Bdx. 4-10-50	4,000	5 16 0	160	120	20	12 10 0	18 6 0	—	16 8	19 2 8	1.2	1 9 10	Interruptions by Rain.
April 24 ..	Malvern	4 h.p.	4 Lances	Bdx. 4-10-50	420	0 14 2	16	5	2	0 19 2	1 13 4	11 4	1 8	2 6 4	3	1 13 4	Application v. thorough.
June 9 ..	do.	do.	do.	Bdx. 2-5-50	360	0 6 0	14	4	1	0 15 10	1 1 10	11 4	10	1 14 0	2	1 1 10	

CIDER MAKING TRIALS FOR THE SEASON 1929-30.

BY O. GROVE.

As last year, the cider apple crop was good in nearly all districts, and the juices were characterised by exceptionally high sugar contents. The average specific gravity of the juices from all the samples examined at the Institute was 1.0575, which is considerably above the normal. The high sugar contents were undoubtedly due to the favourable weather during the summer and autumn of 1929. It was also a good year for perry pears.

THE CIDER AND PERRY COMPETITION.

For the fifth year in succession a competition on similar lines to those described in earlier reports was arranged.

148 entries of fruit were received ; of these 113 were apples and 35 pears. The fruit was stored until judged to be fit for milling, and the subsequent treatment given to each cider or perry was the same except for the following differences as to the filtration period. In Class I the ciders were filtered when the specific gravity of the fermenting juice was 1.028 ; in Classes II and VI, 1.030 ; in Class III, 1.020 ; and in Classes IV and V, 1.025.

Details of entries will be found in Table I below.

The competition was open to growers residing in the counties of Devon, Dorset, Gloucester, Hereford, Monmouth, Somerset and Worcester. The entries from the different counties were distributed as follows :—Devon 10, Dorset 3, Gloucester 41, Hereford 19, Monmouth 27, Somerset 40, and Worcester 8.

The ciders and perries were judged on April 15th and 16th, 1930, by Messrs. G. A. Martin, Bristol ; Wm. D. McCreath, North Petherton, Somerset ; and John H. Wootton, Byford, Hereford.

Class I, Kingston Black, was a very good class. As it will be seen in the Table below, the specific gravities of the juices were exceptionally high, reaching as much as 1.081 in one case. At the same time the acidity of the juices was considerably above normal for this variety, and the ciders were consequently more acid in flavour than usual. The tannin character was also well marked, and the ciders had plenty of “body.”

Class II, sharp varieties, was for the first time divided into two groups: (a) with an acidity of the juices of 0.80% or above, (b) with an acidity below 0.80%. Group (a) comprised ciders which can only be used for blending with ciders of lower acidity, whereas the ciders in group (b) can be used unblended. This division of the sharp class was adopted as a result of the experience of previous years of the difficulty of satisfactory comparison of ciders of widely different acidities and has been found very helpful by the judges.

In group (a) (14 entries), the two samples of Cap of Liberty from Martock were excellent ciders. The Fredericks were next in merit, and Cowarne Red was a very good, sharp cider with an unusually high acidity for the variety. The rest of the samples in this group were not up to the standard of the varieties named, although they were quite good ciders for blending purposes. Honey Hall Red and Sour Hangdown were tried for the first time; the first-named showed an undesirably high rate of fermentation.

In group (b) (12 entries) the two well-known varieties Red Streak and Dymock Red produced ciders of high quality, and the same was the case with Ansell. The fruit of this last variety ripens unusually late and keeps sound for many months. Mullin's White, Wallis and No. 34, Stoke Red, gave very useful ciders. The last-named was perhaps not so good as it has been in some seasons. The other Stoke Red, No. 33, showed an exceptionally low tannin content, which made the cider somewhat insipid in flavour. Both the samples of Golden Ball produced fairly useful ciders, but the juices fermented too quickly. The rest of the entries in the group were of quite fair standard.

Class III, sweet varieties (15 entries), was upon the whole not of great merit. The Sweet Alford's were not quite so good as usual for this excellent variety. Of the four Perthyres entered, No. 44 was the best, a cider of nice flavour, very useful for blending with sharper varieties. No. 52, Woodbine, was a good cider, and so was No. 46, Honeystring, which was tried for the first time. No. 49, Pound Apple, gave a sweet cider of good quality. No. 39, Morgan Sweet, a variety which as a rule produces a rather inferior cider, was this year quite acceptable. Eggleton Styre, Wyatts Seedling and Berkeley Pippin, all gave very fair ciders, the last-named being considered the best of the three.

Class IV, bittersweet varieties (27 entries). This was the best class of the season. As will be seen from the table, the tannin percentages in the ciders were fairly high and the bittersweet character consequently well marked. With the exception of

Sandford Jersey, Councillor, Broadnose Jersey, Hatcher and Wyatts Sweet, all the varieties entered in the class have appeared in these competitions previously. Sandford Jersey gave a cider with a very high tannin content, a typically bittersweet cider with a fairly good flavour, useful for blending purposes. Councillor produced a cider of similar character, a little more coarse in flavour. Broadnose Jersey—which appears to be identical with Strawberry Norman—and Wyatts Sweet gave bittersweet ciders of fair quality, and Hatcher a good cider with a pleasant flavour. As will be seen from the prize list, the well-known varieties Cherry Norman, Royal Wilding and Knotted Kernel were well to the front; very good samples of these excellent bittersweet varieties. Nos. 54, 55, 56 and 57 were all very fair, White Norman being the best of the four. No. 58, Broadleaf Jersey, was rather coarse in character; the juice fermented very rapidly and the cider did not keep very well in bottle. The other varieties entered gave ciders which in most cases were above their usual standard. This was especially marked in the case of No. 75, French, which is not considered of much value as a cider apple.

In Class V, mixed varieties (33 entries), it is interesting to note that the first and the third prize were awarded to ciders made from blends of apples grown in trial orchards established with trees supplied by the Institute. It is also worth noting that the four samples placed first by the judges all contained a proportion of the Kingston Black apple. The chemical analysis of the juices shows that most of the blends were well balanced with regard to acid and tannin contents, which indicates that the apples were blended in suitable proportions of sharp, sweet and bittersweet varieties. A few, such as Nos. 101 and 102, were too high in acid and the tannin content was a little too high in a few others, but upon the whole the blending was good, better than has been the case in former competitions. It will also be noted that the six samples selected for awards had an acidity below 0.50%.

All the ciders in the competition were kept in bottles for about a year. With very few exceptions they kept very well. There were no cases of cider sickness or ropiness and only small yeast deposits were formed in the bottles.

Class VI for perry (35 entries) was a very good class. The first prize, No. 114, Moorcroft, was an exceptionally good perry with a nice fruity flavour. Otherwise the Oldfield pear carried most of the honours, being awarded the 2nd, 3rd and 4th prizes. The Blakeney Reds followed in merit, but the perries made from the Butt pear suffered from excessive astringency. None of the other varieties named in the list produced perries of special merit.

Besides the analyses of the competition ciders and perries, Table I below gives the corresponding data of some ciders made from apples grown in the trial orchard at the Institute, and, of ciders made from blends of Bramley's Seedling and Dabinett. Of these last-named the most palatable cider was that obtained from a blend of equal parts of Bramley's Seedling and Dabinett.

REPORT OF JUDGES ON THE LONG ASHTON CIDER COMPETITIONS 1929-30.

The judging of the ciders in these competitions took place on Tuesday, April 15th, and Wednesday, April 16th.

In Class I, for Kingston Black apples only, there were 12 entries. The ciders were remarkably uniform and all were of good quality. Although hardly up to the best standard of this variety on account of the unusually high acidity and rather pronounced bitterness, they confirmed the view that the Kingston Black is the best of the English cider varieties for use unblended. The colour was rather paler than usual.

Class II, for "Sharp" varieties, has this year been divided into two sections, *A* for very acid sorts suitable only for blending, and *B* for medium acid kinds suitable for use unblended. This division has proved very satisfactory, and the awards have been more straightforward to make.

In the *A* group (14 entries) the prize-winners were sorts of long-recognised value and well earned their position. As a whole this group constituted a good class.

In the *B* group (12 entries) almost every cider was palatable. The results generally were very satisfactory, and all the ciders gaining awards proved to be good enough for use without blending.

Class III, for "sweet" varieties (15 entries), proved to be the most variable and disappointing class of the year. None of the prize-winners reached the best standards of some other years, although all were acceptable. Many of the entries showed a distinct trace of a bitter flavour in spite of the small amount of tannin recorded by the analyses of the juices.

Class IV, the "bittersweet" class, with 27 entries, was the best class of the year. The 1st and 2nd prize-winners were outstanding in merit and the general average of the class was fairly high.

Class V, for blends of apples, showed a great improvement on other years, so far as the general standard of the blending was

concerned. The competitors seem now to have a better idea of the principle of blending. There were 33 entries, and the chief criticism to make of the class as a whole is that in most cases the blends contain no distinctive character. The first three prize-winners were, however, examples of really good blends.

The class for perry (Class VI, 35 entries) just failed to reach last year's abnormally high standard. It was, however, a very good class and much above that of an average year. The first prize perry was regarded as outstanding.

As a whole the colour of the ciders this year is deficient and the body and general fruity character are not so marked as anticipated from the high gravities of the juices and the hot dry summer of 1929.

In conclusion, the cider house staff are to be warmly congratulated on the excellent condition in which the ciders were presented, and in every case the samples had a fair chance of an award so far as care and attention to their making could give it them.

Signed W. D. McCREATH.

JOHN H. WOOTTON.

G. A. MARTIN.

CIDERS.
TABLE I.
COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation.	Date of Filtering.	Specific Gravity at time of Filtering, 1930.	Specific Gravity of May, 1930.	Name and Address of Grower.
CLASS 1.—KINGSTON BLACKS—										
1	Kingston Black	..	1.061	0.65	0.20	4.2	31/1/30	1.028	1.026	E. V. V. Wheeler, Tenbury, Wor.
2	"	..	1.067	0.72	0.23	4.2	5/3/30	1.028	1.028	H. E. Dabinett, Somerton, Som.
3	"	..	1.075	0.76	0.20	4.0	7/4/30	1.028	1.028	E. E. Kingston, Somerton, Som.
4	"	..	1.080	0.89	0.24	4.8	2/4/30	1.028	1.028	W. Wyatt, Kingweston, Som.
5	"	..	1.081	0.89	0.24	6.2	11/2/30	1.028	1.027	J. Maunder, Kingweston, Som.
6	"	..	1.078	0.86	0.25	5.5	10/4/30	1.028	1.028	H. Knight, Huntley, Glos.
7	"	..	1.070	0.80	0.22	3.0	10/4/30	1.028	1.028	H. C. Davis, Hewish, Som.
8	"	..	1.072	0.79	0.24	4.2	7/4/30	1.028	1.028	P. E. Bomford, Upton Snodsbury, Wor.
9	"	..	1.065	0.67	0.21	2.8	19/3/30	1.028	1.028	R. J. Denning, Iminster, Som.
10	"	..	1.061	0.69	0.21	3.2	7/3/30	1.028	1.028	W. H. Hunt, Easton-in-Gordano, Som.
11	"	..	1.065	0.71	0.20	3.5	31/3/30	1.028	1.028	R. J. Wear, Congresbury, Som.
12	"	..	1.056	0.70	0.19	3.4	12/3/30	1.028	1.028	W. R. Thomas, Nunnington, Her.
CLASS 2.—A. SHARP VARIETIES. Acidity 0.8 per cent. or above—										
13	Wagstaff	..	1.068	1.10	0.17	4.8	6/1/30	1.030	1.029	P. E. Bomford, Upton Snodsbury, Wor.
14	Farmers Glory	..	1.051	0.97	0.22	4.0	20/12/29	1.030	1.029	H. C. Davis, Hewish, Som.
15	Frederick	..	1.049	1.03	0.10	3.0	8/1/30	1.030	1.029	W. Beer, Abergavenny, Mon.
16	Frederick	..	1.051	1.04	0.09	3.8	6/1/30	1.030	1.028	A. Williams, Abergavenny, Mon.
17	Frederick	..	1.049	1.08	0.08	3.1	14/12/29	1.030	1.029	A. L. Thomas, Manson, Mon.
18	Frederick	..	1.060	1.10	0.13	3.8	4/1/30	1.030	1.029	J. Mullins, Dingestow, Mon.
19	Cowarne Red	..	1.056	0.92	0.13	4.2	10/1/30	1.030	1.028	W. P. Merrett, Arlingham, Glos.
20	Styre	..	1.059	0.96	0.22	3.7	24/1/30	1.030	1.030	W. Houldey, Newent, Glos.
21	Cap of Liberty	..	1.063	1.10	0.27	3.0	28/3/30	1.030	1.030	E. Hodges, Martock, Som.
22	Cap of Liberty	..	1.063	0.94	0.30	3.8	18/3/30	1.030	1.030	W. Maynard, Martock, Som.
23	Honey Hall Red	..	1.056	0.80	0.22	8.0	9/12/29	1.030	1.021	R. J. Wear, Congresbury, Som.
24	Sour Hangdown	..	1.048	0.90	0.23	6.2	9/12/29	1.030	1.028	M. J. Pearce, Winford, Som.
25	Rough Coats	..	1.054	0.93	0.10	4.0	21/12/29	1.030	1.030	T. R. Price, Westhide, Her.
26	Hartisman	..	1.046	0.81	0.16	4.0	28/12/29	1.030	1.028	W. H. Hunt, Easton-in-Gordano, Som.

TABLE I.—*continued.*

CIDERS.		COMPETITION VARIETIES.									
CLASS 2.—B. MEDIUM SHARP		VARIETIES. Acidity below 0.8 per cent.—									
27	White Sharp	..	22/10/29	1.051	0.68	0.14	3.3	18/12/29	1.030	1.029	W. H. Hunt, Easton-in-Gordano, Som.
28	Golden Ball No. 1	..	1/11/29	1.045	0.66	0.16	8.3	15/11/29	1.030	1.025	J. Bowditch, Stoke Abbott, Dorset.
29	Golden Ball No. 2	..	1/11/29	1.048	0.62	0.15	9.3	16/11/29	1.030	1.026	J. Bowditch, Stoke Abbott, Dorset.
30	Dymock Red	..	1/11/29	1.069	0.61	0.31	6.3	20/1/30	1.030	1.029	R. E. Turner, Dymock, Glos.
31	Strawberry Apple	..	4/11/29	1.058	0.64	0.28	6.2	4/12/29	1.030	1.023	E. T. Lewis, Madley, Her.
32	Red Streak	..	8/11/29	1.052	0.62	0.10	2.7	10/1/30	1.030	1.029	H. Knight, Huntley, Glos.
33	Stoke Red	..	8/11/29	1.053	0.48	0.09	5.0	5/12/29	1.030	1.029	E. W. Morgan, Wedmore, Som.
34	Stoke Red	..	11/11/29	1.054	0.51	0.25	4.8	9/12/29	1.030	1.030	H. H. Sealy, Rodney Stoke, Som.
35	Pages Yellow	..	12/11/29	1.063	0.69	0.17	5.2	8/1/30	1.030	1.030	Rt. Hon. Lord Bledisloe, Lydney, Glos.
36	Mullins White	..	21/11/29	1.058	0.48	0.21	6.0	12/12/29	1.030	1.029	J. Mullins, Dingslow, Mon.
37	Wallis	..	28/11/29	1.055	0.77	0.18	5.0	6/1/30	1.030	1.029	J. Crang, Kingsdon, Som.
38	Ansell	..	11/12/29	1.060	0.54	0.20	5.6	6/1/30	1.030	1.028	W. P. Merrett, Arlingham, Glos.
CLASS 3.—SWEET VARIETIES—											
39	Morgan Sweet	..	15/10/29	1.059	0.32	0.14	8.2	11/11/29	1.020	1.018	R. J. Wear, Congresbury, Som.
40	Perthyres	..	22/10/29	1.053	0.37	0.17	7.4	14/11/29	1.020	1.016	A. T. Blake & Son, Monmouth.
41	Perthyres	..	22/10/29	1.057	0.30	0.16	8.4	11/11/29	1.020	1.016	E. J. Powell, Monmouth.
42	Perthyres	..	23/10/29	1.056	0.33	0.19	4.5	21/11/29	1.020	1.019	W. Beer, Abergavenny, Mon.
43	Eggleton Styre	..	24/10/29	1.053	0.33	0.15	7.0	14/11/29	1.020	1.015	F. Pole, Holmer, Her.
44	Perthyres	..	4/11/29	1.059	0.33	0.18	7.2	6/12/29	1.020	1.019	J. Mullins, Dingslow, Mon.
45	Sweet Alford	..	7/11/29	1.059	0.24	0.18	3.4	1/2/30	1.020	1.020	H. Daniel, Honiton, Devon.
46	Honeystring	..	8/11/29	1.051	0.23	0.17	5.5	9/12/29	1.020	1.020	G. Look, Shepton Mallet, Som.
47	Sweet Alford	..	12/11/29	1.062	0.25	0.16	5.2	4/2/30	1.020	1.020	J. T. Shield, Berkeley, Glos.
48	Woodbine	..	13/11/29	1.050	0.45	0.19	3.7	18/1/30	1.020	1.020	W. H. Arundell, Crediton, Devon.
49	Pound Apple	..	15/11/29	1.057	0.24	0.13	6.2	13/12/29	1.020	1.018	H. Daniel, Honiton, Devon.
50	Sweet Alford	..	21/11/29	1.060	0.27	0.14	4.6	20/3/30	1.020	1.020	W. J. Berry, Newton St. Cyres, Devon.
51	Wyatt's Seedling	..	25/11/29	1.054	0.39	0.14	4.2	17/1/30	1.020	1.020	W. J. Berry, Newton St. Cyres, Devon.
52	Woodbine	..	25/11/29	1.062	0.26	0.19	5.5	18/1/30	1.020	1.020	W. Hill, Kittisford, Som.
53	Berkeley Pippin	..	26/11/29	1.060	0.27	0.15	6.6	13/1/30	1.020	1.019	V. J. Davis, Berkeley, Glos.

TABLE 1.—*continued.*
COMPETITION VARIETIES.

CIDERS.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation.	Date of Filtering.	Specific Gravity at time of May, Filtering, 1930.	Name and Address of Grower.
CLASS 4.—BITTERSWEET VARIETIES—									
54	Royal George	15/10/29	1.055	0.25	0.22	4.5	25/11/29	1.025	W. H. Hunt, Easton-in-Gordano, Som.
55	Belle Norman	23/10/29	1.052	0.33	0.22	5.7	13/11/29	1.025	A. Williams, Abergavenny, Mon.
56	White Norman	24/10/29	1.057	0.21	0.31	3.4	7/1/30	1.025	W. R. Thomas, Nunnington, Her.
57	Broadleaf Norman	29/10/29	1.052	0.23	0.18	7.0	21/11/29	1.025	E. V. V. Wheeler, Tenbury, Wor.
58	Broadleaf Jersey	29/10/29	1.057	0.38	0.26	7.5	12/11/29	1.025	A. T. Blake & Son, Monmouth.
59	Cherry Norman	29/10/29	1.060	0.31	0.23	6.6	5/12/29	1.025	W. Beer, Abergavenny, Mon.
60	Belle Norman	1/11/29	1.059	0.34	0.19	7.2	27/11/29	1.025	C. F. Chapman, Westhide, Her.
61	Cummy Norman	1/11/29	1.065	0.34	0.27	6.2	16/12/29	1.025	J. E. Edwards, Norton Canon, Her.
62	Royal Wilding	4/11/29	1.064	0.31	0.26	5.7	14/12/29	1.025	Sir J. R. G. Cotterell, Bt., Bridge Sollers, Her.
63	Knotted Kernel	7/11/29	1.064	0.32	0.35	3.1	3/2/30	1.025	J. E. Edwards, Norton Canon, Her.
64	Dove	7/11/29	1.060	0.29	0.31	4.5	19/12/29	1.025	W. Wyatt, Kingweston, Som.
65	Wyatt's Sweet	7/11/29	1.062	0.23	0.22	7.7	2/12/29	1.025	W. Wyatt, Kingweston, Som.
66	Stable Jersey	8/11/29	1.060	0.29	0.37	9.0	27/11/29	1.025	G. Look, Shepton Mallet, Som.
67	Sandford Jersey	8/11/29	1.059	0.27	0.41	5.5	16/12/29	1.025	T. G. Vincent, Shepton Mallet, Som.
68	Strawberry Norman	12/11/29	1.059	0.37	0.35	7.0	18/12/29	1.025	J. P. Eley, Frampton Cotterell, Glos.
69	Strawberry Norman	13/11/29	1.060	0.42	0.37	6.0	28/12/29	1.025	W. Houldey, Newent, Glos.
70	Red French	14/11/29	1.062	0.28	0.25	6.7	4/1/30	1.025	R. T. Hinckes, Mansel Court, Her.
71	Cherry Norman	15/11/29	1.055	0.26	0.26	5.0	28/1/30	1.025	W. R. Thomas, Nunnington, Her.
72	Councillor	25/11/29	1.066	0.28	0.38	5.6	20/12/29	1.025	T. Pawkes, Leonard Stanley, Glos.
73	Broadnose Jersey	25/11/29	1.061	0.28	0.23	7.1	30/12/29	1.025	A. G. Barber, Ditchbeat, Som.
74	French	26/11/29	1.047	0.24	0.24	5.5	16/12/29	1.025	W. Beer, Abergavenny, Mon.
75	French	27/11/29	1.060	0.28	0.33	6.3	16/12/29	1.025	A. T. Blake & Son, Monmouth.
76	Hatcher	29/11/29	1.065	0.32	0.21	6.4	2/1/30	1.025	N. H. Padfield, Corse, Wor.
77	Chisel Jersey	29/11/29	1.060	0.27	0.34	5.6	6/1/30	1.025	T. H. Gollidge, Shepton Mallet, Som.
78	Chisel Jersey	29/11/29	1.051	0.23	0.32	4.8	10/1/30	1.025	T. G. Vincent, Shepton Mallet, Som.
79	Royal Wilding	3/12/29	1.060	0.29	0.31	4.0	27/1/30	1.025	T. R. Price, Westhide, Her.
80	Dabinett	3/12/29	1.046	0.26	0.23	3.4	18/12/29	1.025	J. Baker, Bassaleg, Mon.

TABLE I.—*continued.*
COMPETITION VARIETIES.

CIDERS.

CLASS 5.—MIXED VARIETIES—

81	Perthyres 7, Eggle- ton Styre 4, Fred- erick 2 $\frac{1}{2}$, Red Apple 1 $\frac{1}{2}$	22/10/29	1.057	0.44	0.17	7.4	11/11/29	1.025	1.023	A. T. Blake & Son, Monmouth.
82	Foxwhelp 1, Sweet Alford 2, Perthyres 9, Frederick 3 ..	23/10/29	1.053	0.49	0.19	5.7	18/11/29	1.025	1.023	W. Beer, Abergavenny, Mon.
83	White Hangdown 8, Strode Sharp 2, Strode Bittersweet 5	23/10/29	1.055	0.57	0.21	5.0	22/11/29	1.025	1.025	M. J. Pearce, Winford, Som.
84	Nempnett Sweet 10, Nempnett Sharp 4, Nempnett Mild Sharp 1	29/10/29	1.054	0.42	0.14	7.0	15/11/29	1.025	1.017	A. Daunton, Nempnett, Som.
85	Kingston Black 3, Hangdown 4, Slack- ma-Girdle 4, Sour Natural 4	29/10/29	1.054	0.47	0.21	8.0	18/11/29	1.025	1.021	W. H. Arundell, Crediton, Devon.
86	Sweet Alford 4, Sweet Coppin 2, Plym- tree Sour 5, Trem- lett's Bitter 4 ..	29/10/29	1.054	0.53	0.17	6.0	7/12/29	1.025	1.024	J. W. Hussey, Cullompton, Devon.
87	Golden Ball 10, Jayes 5	1/11/29	1.051	0.54	0.18	7.7	3/12/29	1.025	1.024	J. Bowditch, Stoke Abbott, Dorset.
88	Fair Maid of Devon 5, Sweet Alford 5, Pocket Apple 5 ..	8/11/29	1.051	0.35	0.14	3.7	31/12/29	1.025	1.024	H. Hoare, Buckfastleigh, Devon.

TABLE I.—*continued*.

CIDERS.

COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent. fermentation.	Date of Filtering.	Specific Gravity at time of May, 1930.	Name and Address of Grower.		
CLASS 5.—MIXED VARIETIES— <i>continued</i> .										
89	Redwood Bitter 6, Devonshire Dosssets 2, Redwood Sweet 4, Redwood Sharp 3	11/11/29	1.053	0.58	0.31	6.3	12/12/29	1.025	1.025	F. Reynolds, Barrow Gurney, Som.
90	Pages Yellow 5, Table Top 5, Brice's Kernel 5 ..	12/11/29	1.055	0.64	0.17	7.0	6/12/29	1.025	1.025	Rt. Hon. Lord Bledisloe, Lydney, Glos.
91	Strawberry Norman 5, Frederick 6, Styre Wilding 4 ..	12/11/29	1.051	0.58	0.20	3.8	9/1/30	1.025	1.024	A. Williams, Abergavenny, Mon.
92	Foxwhelp 2, King- ston Black 4, Sweet Alford 7, Knotted Kernel 2 ..	12/11/29	1.059	0.40	0.22	5.0	4/1/30	1.025	1.024	J. P. Eley, Frampton Cotterell, Glos.
93	Chisel Jersey 4, Berkeley Pippin 3, Honey Red 4, Kingston Black 4	13/11/29	1.057	0.73	0.16	5.7	21/12/29	1.025	1.025	R. J. Wear, Congresbury, Som.

TABLE I.—*continued.*

CIDERS.		COMPETITION VARIETIES.								
CLASS 5.—MIXED VARIETIES— <i>continued.</i>										
94	Sweet Alford 5, Royal Jersey 3, Yarlington Mill 4½, Cadbury 2½ ..	13/11/29	1.059	0.29	0.24	5.0	4/1/30	1.025	1.025	H. Hawkins, Brookthorpe Court, Glos.
95	Cap of Liberty 5, Royal Jersey 5, White Jersey 5	13/11/29	1.064	0.38	0.27	5.4	17/1/30	1.025	1.025	J. C. Moody, East Pennard, Som.
96	Red Streak 5, Royal Wilding 4, Green French 6 ..	14/11/29	1.058	0.40	0.22	8.3	18/12/29	1.025	1.023	R. T. Hinekes, Mansel Court, Her.
97	Kingston Black 5, Sharp Apple 4, Strawberry Nor- man 6 ..	15/11/29	1.057	0.47	0.24	3.7	28/1/30	1.025	1.024	J. E. Edwards, Norton Canon, Her.
98	Hangdown 5, King- ston Black 5, Bitter Pullins 2, Bitter Wines 3 ..	15/11/29	1.064	0.38	0.20	5.0	3/1/30	1.025	1.023	A. Dibble, Ilminster, Som.
99	Chisel Jersey 7, Sweet Alford 4, Fair Maid of Devon 4 ..	15/11/29	1.048	0.39	0.20	5.0	20/1/30	1.025	1.024	J. Baker, Bassaleg, Mon.
100	Kingston Black 5, Wallis 5, Hang- down 5 ..	15/11/29	1.056	0.54	0.22	5.2	16/1/30	1.025	1.025	J. F. Day, Edingworth, Som.
101	White Crab 7, Chat- ley Apple 8 ..	15/11/29	1.057	0.83	0.24	6.2	9/1/30	1.025	1.025	T. H. Brookes, Cheltenham, Glos.

TABLE I.—*continued.*

CIDERS.

COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity of May, 1930.	Name and Address of Grower.
CLASS 5.—MIXED VARIETIES— <i>continued.</i>										
102	Hartisman 2, White Sharp 3, White Georges 5, Bastard Tom Putt 5 ..	20/11/29	1.048	0.74	0.24	2.8	14/2/30	1.025	1.025	W. H. Hunt, Easton-in-Gordano. Som.
103	Red Streak 5, Woodbine 5, Cap of Liberty 2, Red Jersey 3 ..	20/11/29	1.056	0.56	0.22	5.2	17/1/30	1.025	1.024	R. J. Denning, Ilminster, Som.
104	Hangdown 4, Marshall's Bittersweet 3, Regil Red Streak 4, Strode Red Streak 4 ..	20/11/29	1.057	0.65	0.30	5.0	20/1/30	1.025	1.023	B. Pearce, Winford, Som.
105	Eggleton Styre 6, Kingston Black 4, Rouge Bruyere 2, Backwell Red 3 ..	20/11/29	1.063	0.37	0.19	5.3	11/1/30	1.025	1.025	J. T. Shield, Berkeley, Glos.
106	Perthyres 5, Fred-erick 5, Golden Styre 5 ..	21/11/29	1.051	0.51	0.13	6.6	9/12/29	1.025	1.023	S. W. Mullins, Raglan, Mon.

TABLE I.—*continued.*

CIDERS.		COMPETITION VARIETIES.						
CLASS 5.— MIXED VARIETIES— <i>continued.</i>								
107	Frederick 5, Golden Ball 3, Perthryes 5, King of the Orchard 2 ..	21/11/29	1.055	0.63	0.11	7.2	7/1/30	1.025 1.023 J. Mullins, Dingestow, Mon.
108	Kingston Black 5, Eggleton Styre 4, Sweet Alford 3, Strawberry Norman 3 ..	25/11/29	1.066	0.34	0.22	5.1	5/2/30	1.025 1.025 H. T. Phelps, Tibberton, Glos.
109	Five Apple 5, Port Wine Jersey 5, Chisel Jersey 5 ..	25/11/29	1.055	0.33	0.32	4.5	14/1/30	1.025 1.025 T. G. Vincent, Shepton Mallet, Som.
110	Tale Sour 7, Woodbine 5, Tale Bitter 3	25/11/29	1.056	0.49	0.25	6.8	30/12/29	1.025 1.024 H. Daniel, Honiton, Devon.
111	Kingston Black 5, Royal Jersey 3, Yarlington Mill 4, Cap of Liberty 3	25/11/29	1.060	0.46	0.30	5.3	18/2/30	1.025 1.024 A. G. Barber, Ditcheat, Som.
112	Brown Snout 5, Cunny Norman 5, Philmander 5 ..	26/11/29	1.063	0.54	0.33	8.5	30/12/29	1.025 1.023 C. F. Chapman, Westhide, Her.
113	Kingston Black 3, Dabinett 4, Porter's Perfection 4, Jersey 4 ..	27/11/29	1.061	0.48	0.33	4.5	17/1/30	1.025 1.024 G. J. Tatchell, East Lambrook, Som.

TABLE I.—*continued.*

PERRIES.

COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent. fermentation.	Rate of fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity of May, 1930.	Name and Address of Grower.
CLASS 6.—PERRIES—										
114	Moorcroft	15/10/29	1.069	0.49	0.13	5.0	16/12/29	1.030	1.028	J. Lloyd, Newent, Glos.
115	Blakeney Red	15/10/29	1.058	0.40	0.17	3.7	10/12/29	1.030	1.030	J. Lloyd, Newent, Glos.
116	Green Huffcap	15/10/29	1.066	0.48	0.15	7.4	20/11/29	1.030	1.028	J. Lloyd, Newent, Glos.
117	Blakeney Red	21/10/29	1.047	0.36	0.14	2.1	18/12/29	1.030	1.030	W. P. Merrett, Arlingham, Glos.
118	Blakeney Red	21/10/29	1.052	0.42	0.10	3.1	10/12/29	1.030	1.029	A. T. Blake & Son, Monmouth.
119	Betty Prosser	21/10/29	1.065	0.56	0.09	5.8	18/12/29	1.030	1.029	A. T. Blake & Son, Monmouth.
120	Blakeney Red	22/10/29	1.062	0.52	0.21	4.0	6/1/30	1.030	1.029	E. J. Powell, Monmouth.
121	Blakeney Red	22/10/29	1.058	0.42	0.16	2.6	20/1/30	1.030	1.030	H. Knight, Huntley, Glos.
122	Aylton Red	22/10/29	1.061	0.34	0.13	3.8	19/12/29	1.030	1.030	H. Knight, Huntley, Glos.
123	Runny Bobs	24/10/29	1.054	0.93	0.11	4.2	12/12/29	1.030	1.027	P. E. Bomford, Upton Snodsbury, Wor.
124	Red Horse Pear	24/10/29	1.056	0.72	0.15	5.6	26/11/29	1.030	1.029	P. E. Bomford, Upton Snodsbury, Wor.
125	Blakeney Red	24/10/29	1.058	0.49	0.15	4.6	20/12/29	1.030	1.030	R. E. Turner, Dymock, Glos.
126	Holmer	24/10/29	1.067	0.77	0.21	5.4	24/1/30	1.030	1.030	F. Pole, Holmer, Her.
127	Blakeney Red	24/10/29	1.060	0.57	0.13	4.8	16/12/29	1.030	1.029	R. Hyett, Dymock, Glos.
128	Blakeney Red	29/10/29	1.055	0.38	0.10	4.2	16/12/29	1.030	1.028	W. Houldey, Newent, Glos.
129	Blakeney Red	1/11/29	1.055	0.47	0.13	4.2	18/12/29	1.030	1.030	A. L. Thomas, Manson, Mon.
130	Blakeney Red	4/11/29	1.051	0.40	0.11	3.2	9/12/29	1.030	1.030	J. Mullins, Dingtew, Mon.
131	Oldfield ?	8/11/29	1.051	0.21	0.23	3.6	2/12/29	1.030	1.027	T. H. Brookes, Cheltenham, Glos.
132	Blakeney Red	11/11/29	1.046	0.31	0.08	4.1	6/12/29	1.030	1.027	Rt. Hon. Lord Bledisloe, Lydney, Glos.
133	Blakeney Red	11/11/29	1.049	0.29	0.10	4.0	18/12/29	1.030	1.030	T. R. Price, Westthide, Her.
134	Oldfield ?	13/11/29	1.059	0.37	0.12	9.0	18/12/29	1.030	1.029	G. Cobb, Dymock, Glos.
135	Russett Pear	21/11/29	1.056	0.54	0.11	9.2	9/12/29	1.030	1.020	H. Knight, Huntley, Glos.
136	Oldfield	26/11/29	1.063	0.65	0.13	3.8	27/2/30	1.030	1.030	H. Knight, Huntley, Glos.

TABLE II.

COMPETITION CIDERS AND PERRIES, 1929-30.

JUDGES' AWARDS.

CIDERS.

Class 1.		No. KINGSTON BLACK. (12 Entries).	
First Prize	..	12	W. R. Thomas, Nunnington, Hereford.
Second Prize	..	2	H. E. Dabinett, Somerton, Som.
Third Prize	..	8	P. E. Bomford, Upton Snodsbury, Wor.
Fourth Prize	..	10	W. H. Hunt, Easton-in-Gordano, Som.
Reserve	..	7	H. C. Davis, Hewish, Som.
Very Highly Com'ded		9	R. J. Denning, Ilminster, Som.
Class 2. A.		SHARP VARIETIES. (Acidity 0.8% or above).	
		No. (14 Entries).	Variety.
First Prize	..	22	W. Maynard, Martock, Som. Cap of Liberty.
Second Prize	..	21	E. Hodges, Martock, Som. Cap of Liberty.
Third Prize	..	18	J. Mullins, Dingestow, Mon. Frederick.
Fourth Prize	..	19	W. P. Merrett, Arlingham, Glos. Cowarne Red.
Reserve	..	17	A. L. Thomas, Manson Farm, Mon. Frederick.
Very Highly Com'ded		15	W. Beer, Abergavenny, Mon. Frederick.
Class 2. B.		MEDIUM SHARP VARIETIES (Acidity below 0.8%).	
		(12 Entries).	Variety.
First Prize	..	32	H. Knight, Huntley, Glos. Red Streak.
Second Prize	..	38	W. P. Merrett, Arlingham, Glos. Ansell.
Third Prize	..	30	R. E. Turner, Dymock, Glos. Dymock Red.
Fourth Prize	..	36	J. Mullins, Dingestow, Mon. Mullin's White.
Reserve	..	37	J. Crang, Kingsdon, Som. Wallis.
Very Highly Com'ded		34	H. H. Sealy, Rodney Stoke, Som. Stoke Red.
Class 3.		SWEET VARIETIES. (15 Entries).	
First Prize	..	50	W. J. Berry, Newton St. Cyres, Devon Sweet Alford.
Second Prize	..	44	J. Mullins, Dingestow, Mon. Perthryres.
Third Prize	..	49	H. Daniel, Honiton, Devon Pound Apple.
Fourth Prize	..	45	H. Daniel, Honiton, Devon Sweet Alford.
Reserve	..	46	G. Look, Shepton Mallet, Som. Honeystring.
Very Highly Com'ded		52	W. Hill, Kittisford, Som. Woodbine.

*Class 4.*BITTERSWEET VARIETIES. (27 *Entries*).

First Prize	..	71	W. R. Thomas, Nunnington, Hereford	Cherry Norman.
Second Prize	..	79	I. R. Price, Westhide, Hereford	Royal Wilding.
Third Prize	..	62	Sir J. R. G. Cotterell, Bridge Sollers	Royal Wilding.
Fourth Prize	..	63	J. E. Edwards, Norton Canon, Her.	Knotted Kernel.
Reserve	76	N. H. Padfield, Corse, Wor. ..	Hatcher.	
Very Highly Com'ded	75	A. T. Blake & Son, Monmouth	French.	

*Class 5.*MIXED VARIETIES. (33 *Entries*).

First Prize	..	108	H. J. Phelps, Tibberton, Glos.	
Second Prize	..	113	G. J. Tatchell, East Lambrook, Som.	
Third Prize	..	105	J. T. Shield, Berkeley, Glos.	
Fourth Prize	..	111	A. G. Barber, Ditcheat, Som.	
Reserve	95	J. C. Moody, East Pennard, Som.		
Very Highly Com'ded	88	H. Hoare, Buckfastleigh, Devon.		

*Class 6.*PERRIES. (35 *Entries*).*Variety.*

First Prize	..	114	J. Lloyd, Newent, Glos. ..	Moorcroft.
Second Prize	..	138	C. G. Ricketts, Dymock, Glos.	Oldfield.
Third Prize	..	140	F. Pole, Holmer, Her. ..	Oldfield.
Fourth Prize	..	141	I. R. Price, Westhide, Her. ..	Oldfield.
Reserve	139	Mrs. L. Kemp, Brookthorpe, Glos.	Oldfield.	
Very Highly Com'ded	125	R. E. Turner, Dymock, Glos.	Blakeney Red	
Very Highly Com'ded	127	R. Hyett, Dymock, Glos. ..	Blakeney Red.	

CIDER MAKING TRIALS WITH NOVA SCOTIAN APPLES.

BY O. GROVE.

The problem of the profitable utilisation of apples below the accepted market grades is now beginning to receive serious attention in all countries where commercial apple culture is established extensively. Their use for cider production offers a possible outlet, and the Annual Report of this Station for 1927 records the results of cider-making tests on Tasmanian apples at Long Ashton, these tests having been arranged at the desire of the Australian Government.

Corresponding tests with fruit grown in Nova Scotia were undertaken by this Station during the cider-making season of 1929-30 at the instance of the Department of Agriculture of the Dominion of Canada, through which body the required supplies of fruit were secured.

The varieties tested were all market sorts commonly grown in Eastern Canada. About half a ton of apples of each variety was used. The fruit in each instance was of No. 3 grade, packed in barrels, and was in good condition when received.

The apples were kept in store for some time after receipt, until considered fit for milling. The usual cider-making procedure was then followed. The fermenting juices were filtered with an ordinary pulp filter when the specific gravities had fallen to 1.025-1.032. Samples of all ciders were bottled directly after filtration.

The following table gives the chemical analyses of the fresh juices and other particulars :—

ANALYTICAL DATA OF CIDERS MADE FROM NOVA SCOTIAN APPLES.

Name of Variety.	Date of Making.	Yield of Fresh Juice.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermentation.	Date of Filtration.	Specific Gravity at time of Filtration.	Specific Gravity 1st July 1930.	Alcohol per cent. by Weight.
Quaker Beauty ..	15/10/29	165 gallons per ton	1.067	0.77	0.07	6.5	1/11/29	1.032	1.029	3.6
Baldwin ..	9/1/30	169 "	1.046	0.64	0.08	4.2	3/2/30	1.032	1.029	2.7
Wellington ..	9/1/30	180 "	1.043	0.98	0.08	2.5	3/2/30	1.032	1.031	1.7
King ..	9/1/30	178 "	1.045	0.37	0.07	3.0	3/2/30	1.030	1.029	2.5
Ribston ..	9/1/30	167 "	1.059	0.71	0.09	5.2	6/2/30	1.032	1.031	3.4
Stark ..	19/3/30	161 "	1.054	0.37	0.09	7.8	9/4/30	1.025	1.025	3.5
Ben Davis ..	19/3/30	152 "	1.050	0.42	0.07	4.6	9/4/20	1.025	1.025	3.0
Nonpareil ..	21/3/30	160 "	1.058	0.61	0.12	6.6	14/4/30	1.028	1.028	3.5
Fallowater ..	21/3/30	168 "	1.048	0.38	0.08	7.6	10/4/30	1.025	1.025	2.8

The bottled samples were examined in July and all were found then to be in a light sparkling condition. The following notes on their characters were made at the time of examination :—

Name of Variety.	Colour.	Flavour.	Deposit.
Quaker Beauty ..	Light	Clean and quite pleasant	Some.
Baldwin ..	"	Very brisk and quite pleasant ..	Small.
Wellington ..	"	Very acid	"
King ..	"	Rather peculiar, not very good ..	"
Ribston ..	"	Brisk and pleasant	"
Stark ..	"	Sweet and mild, but not good ..	"
Ben Davis ..	"	Quite fair, rather insipid	"
Nonpareil ..	"	Clean and pleasant	"
Fallawater ..	"	Rather poor	"

Ribston and Nonpareil were considered the two best samples. Wellington is too high in acid content, and can only be used blended with varieties with lower acid.

Compared with ciders made from English cider apples all the above ciders were somewhat lacking in "body." This is to a large extent due to the low tannin contents.

All the samples kept well during the summer.

THE EFFECTS OF STORAGE TEMPERATURE ON CIDER—II.

BY O. GROVE.

The experiment on the effects of storage temperature on cider described in last year's report have been extended during the 1929-30 season. The details and results of these are recorded below.

SERIES A.

In May bottled samples of several different ciders were placed in cold storage (Temp. $1^{\circ}\text{C}.$). They were removed in December for comparison with corresponding bottled samples of the same ciders stored throughout that period at the ordinary cellar temperature (7° - $12^{\circ}\text{C}.$).

The appended Table I gives the composition of the ciders, and the figures for the specific gravity and acid after the period of storage in each case.

The most important fact of practical significance to note in Table I is the difference in acidity between the samples stored at $1^{\circ}\text{C}.$ and the corresponding samples stored at cellar temperature. The breakdown of the acid, which normally takes place in a more or less pronounced degree in all ciders during storage at ordinary temperatures, especially in those with a high acid content originally, is obviously prevented at a temperature bordering on freezing point.

As expected, there was hardly any drop in specific gravity in the cold-stored samples, whereas the samples stored at cellar temperature lost on an average four points in specific gravity.

With regard to flavour the difference in acid content naturally caused a marked distinction, especially in the case of the ciders with relatively high acidity. The cold stored samples were much brisker in flavour than the corresponding control samples at ordinary temperature.

Upon the whole the differences with regard to flavour, colour and deposits in the bottles were very similar to the differences observed in the experiments mentioned in last year's report.*

* Annual Report 1929, page 197.

SERIES B.

A blend made from 15 different ciders was bottled in May, and samples were placed in cold store for different periods as indicated in Table II.

Comparing the above samples and taking into account collectively the condition as regards flavour, deposit, colour and effervescence, No. 3 gave the best results, followed closely by Nos. 2 and 5.

Judging from the results obtained by these trials and the experiments made a year previously, it appears that a satisfactory procedure to adopt for the average naturally conditioned bottled cider to restrict detrimental changes in bottle is to keep the bottles at ordinary temperature for 6-8 weeks after the usual spring bottling period, until they are in a suitable sparkling condition with a minimum of deposit, and then to place them in cold store for a period of 8-12 weeks.

This period of cold storage appears to have the effect of checking to a great extent any further growth of the yeast after the bottles are taken out and stored at ordinary cellar temperature. Further evidence on this point is required before a more positive statement can be made, and this it is hoped to secure from the additional experiments now in hand.

In practice the scheme would work out as follows: If a cider maker bottled a stock of cider during March and April, he would dispose of a certain amount during April, May and June. By about the middle of June the quantity wanted for disposal during the later summer and autumn months should be placed in cold store for about 8 weeks. There is as a rule no trouble with too much after-fermentation in the bottles during the late spring and early summer, but from mid-summer onwards the yeast-action is enhanced by the increase in temperature and excessive gas, and deposit development is the result.

The cost of cold storage works out at about 30 shillings per ton per month. For larger quantities and longer storage the cost would be lower. Eighty dozen filled champagne pint bottles or 45 dozen champagne quart bottles weigh approximately one ton. The cost of one month's cold storage would consequently be 4½d. per dozen for champagne pint bottles, and 8d. per dozen for champagne quart bottles.

TABLE I.
COMPARATIVE RESULTS OF STORAGE AT ORDINARY TEMPERATURE AND 1° C. RESPECTIVELY.

Name of Variety and Date of Bottling and Filtering.	Specific Gravity.				Acid % (as Malic Acid).			
	Fresh Juice November 1929.	Cider May 1930.	December 1930.		Fresh Juice.	Cider May 1930.	December 1930.	
			Cellar.	Cold Store.			Cellar.	Cold Store.
Kingston Black 1 .. 2/4/30	1.080	1.028	1.024	1.027	0.89	0.89	0.48	0.92
Kingston Black 2 .. 10/4/30	1.081	1.028	1.025	1.026	0.86	0.93	0.53	0.90
Frederick .. 14/12/29	1.049	1.029	1.026	1.029	1.08	1.07	0.69	1.04
Cap of Liberty .. 28/3/30	1.063	1.030	1.028	1.030	1.10	1.08	0.86	1.14
Dymock Red .. 20/1/30	1.069	1.029	1.027	1.028	0.61	0.71	0.72	0.72
Sweet Alford .. 4/2/30	1.062	1.020	1.018	1.020	0.25	0.28	0.24	0.27
Woodbine .. 18/1/30	1.062	1.020	1.017	1.018	0.26	0.37	0.24	0.36
Royal Wilding .. 14/12/29	1.064	1.023	1.019	1.021	0.31	0.38	0.31	0.32
Chisel Jersey .. 6/1/30	1.060	1.024	1.021	1.023	0.27	0.36	0.23	0.34
Dabinett .. 18/12/29	1.046	1.023	1.020	1.022	0.26	0.32	0.24	0.27
Mixed Apples 1 .. 11/1/30	1.063	1.023	1.019	1.022	0.37	0.56	0.36	0.56
Mixed Apples 2 .. 18/2/30	1.060	1.024	1.020	1.023	0.46	0.60	0.40	0.57

TABLE II.

EFFECTS OF VARYING PERIODS OF STORAGE AT ORDINARY TEMPERATURE AND 1° C.

	Specific Gravity.		Acid % (as Malic Acid).		December, 1930.		
	May 1930. At Bottling.	December 1930.	May 1930. At Bottling.	December 1930.	Deposit.	Effervescence.	Flavour.
1. At cellar temperature the whole period	1.021	1.018	0.62	0.35	Some	Strong	Fair
2. One month at cellar temperature, in cold store rest of period	1.021	1.020	0.62	0.59	Very small	Good	Good
3. Two months at cellar temperature, in cold store rest of period	1.021	1.020	0.62	0.55	Very small	Good	Very good
4. In cold store one month, at cellar temperature rest of period	1.021	1.018	0.62	0.37	Small	Good	Fair
5. In cold store three months, at cellar temperature rest of period	1.021	1.020	0.62	0.55	Very small	Fair	Good
6. In cold store the whole period ..	1.021	1.021	0.62	0.61	None	Feeble	Good

THE CLARIFICATION OF CIDERS BY THE CENTRIFUGE METHOD—I.

BY B. T. P. BARKER AND O. GROVE.

Since the beginning of the present century the clarification of ciders and the consequent control of fermentation have been achieved by most up-to-date cider makers by the use of some form of pressure filter. Efficient as are the modern forms of filters, their limitations are familiar to all users. Of those reference need only be made here to the difficulties attendant on the clarification of ciders in the earliest stages of fermentation. The filter has been also under some suspicion ever since its first introduction as to its influence on the "body" of cider, many contending that a filtered cider loses some of its body in the process.

As an alternative to the filter the centrifuge has been occasionally suggested. Hitherto there has been no suitable opportunity for carrying out practical-scale trials of the centrifuge at Long Ashton, but during the cider-making season of 1929-30 owing to the courtesy of the Super Centrifugal Engineers, Ltd., it became possible to conduct a series of experiments with the Sharples Super Centrifuge. These experiments, the outcome of some laboratory tests made a year previously, were essentially of a preliminary character and are being followed up by further trials, but their results have been of sufficient general interest to justify publication at this stage.

The primary object of the experiments was to compare the centrifuge with the filter as a means of clarifying ciders and controlling their fermentation. This was accomplished by subjecting a selection of various ciders at different stages of fermentation to both forms of treatment and noting any subsequent differences of behaviour, both in cask and bottle. In a few cases the older method of simple racking was also included in the tests.

It is unnecessary to refer in detail to the procedure adopted for filtration. The usual practice was followed, a pulp filter of the Lieberich type being used.

In the case of the centrifuged samples, preliminary tests showed that a satisfactory method was to run the machine at a speed capable of delivering the cleared liquor at the rate of 120 gallons per hour.

This is equivalent to a speed of revolution of the centrifuge at 16,000 revolutions a minute. All the ciders in these comparative experiments were treated at that speed. The liquor was fed to the centrifuge from above by gravity, its rate of flow being regulated by a tap.

Details of the individual ciders used in these tests and data showing the subsequent behaviour of each after treatment in respect of specific gravity and acidity changes are given in Table I appended. Before these are discussed various features which cannot be expressed in that form require mention.

Clarification.

In general, as regards clarification, the filtered samples possessed the degree of extreme brilliancy which is commonly attainable with the modern type of filter. The quantity of cider which could be passed through the filter before the efficiency of filtration became impaired, and repacking of the filter accordingly required, varied according to the nature of the cider and the exact stage of primary fermentation attained at the time of the operation, a result quite in accordance with normal experience and therefore not calling for further remark here. The amount of yeast deposit subsequently formed and its rate of appearance also followed on the usual lines and were determined by the natural rate of fermentation of the juice and the age of the liquor at the time of filtration.

The centrifuged samples lacked the brilliancy of the corresponding filtered material, a slight haziness invariably being present. The haze was partly due to yeast cells in suspension which were not removed during the passage of the liquor through the centrifuge. The number of these residual cells differed somewhat in individual samples, and was controllable to a considerable extent by the speed of working of the centrifuge. A reduction in the rate of output, obtained by reducing the rate of flow from the machine, gave a clearer liquor with fewer yeast cells in suspension. The yeast haze, however, was not the predominant cause of the lack of brilliancy, which was unquestionably due to substances of a colloidal character removable by the filter, but not by the centrifuge.

Although the filtered ciders had an advantage over the centrifuged in degree of brilliancy, in certain other respects the centrifuge possessed compensating advantages in the manner of clarification. It cleared juices of high specific gravity in the earliest stages of fermentation without difficulty, a point in which the filter is notably unsatisfactory. Also there was a considerable saving of time in the working of the machine. Frequent repacking of the

filter involves much delay, while the removal of the bowl of the centrifuge for cleaning purposes and its replacement—an operation required only infrequently—can be effected in about ten minutes. The yeast is deposited on the sides of the bowl as a mass of much the same consistency as dough and is very easily and quickly removed.

For bottling purposes the haziness of the centrifuged liquors is a drawback sufficiently serious to preclude their use for the higher bottling grades. It has been found possible, however, to filter the centrifuged material to brilliant clearness with ease and extreme rapidity. A very large volume can be put through the filter without need for repacking of the latter. It is important in this connection to note that the other characteristic features of a centrifuged cider which are recorded in the remainder of this paper are retained after such filtration, and this procedure thus furnishes a product combining the advantages of both the filtered and the centrifuged articles.

In those cases where racking as a third form of treatment was adopted, the racked ciders as usual lacked the brilliancy of the filtered samples and suffered from yeast haze to a varying degree.

Fermentation Control.

Table I shows the specific gravity changes of the respective ciders after treatment, after storage for lengthy periods in bottle. Those figures, except in the case of Broadleaf Norman, do not reveal a very striking feature of the after-fermentation which was exhibited to a greater or less extent by all the centrifuged samples.

It has been mentioned in the previous section that the yeast was not removed so completely in the centrifuged ciders as in the filtered liquors. In fact the number of yeast cells remaining in the former was by no means inconsiderable, and on that account a distinctly greater amount of after-fermentation was anticipated in those than in the corresponding filtered samples. For some weeks after treatment, however, the remarkable result of less instead of more after-fermentation occurred. Even after the prolonged period of storage till the following December, in no case did the gravity of the centrifuged samples fall more than one point below those of the corresponding filtered samples and in some instances, notably the Broadleaf Norman, the gravity fall was appreciably less than in the filtered ciders.

Further investigation is required before this unexpected effect of the inactivation of the yeast by the centrifuge can be explained, but that such inactivation is associated in some way with and a

direct result of the process seems fairly established in view of the constancy of its occurrence in the very varied types of cider subjected to the treatment.

Flavour and Related Features.

Taking no account of minor differences of flavour in respect of sweetness and acidity—which are readily apparent from the specific gravity and acidity data given in Table I—the ciders clarified by the filter and centrifuge respectively were in nearly all cases clearly distinguishable by the palate; in some to a remarkable extent. The points of difference showed in three directions.

What may be most nearly described as “the flavour of the apple,” or the fruitiness of the liquor, was usually much more marked in the centrifuged ciders: in the outstanding cases it was difficult to recognise that the centrifuged and filtered samples were each derived from the same original juice.

A similar comment applies also to the feature which determines the degree of softness on the palate. Filtered ciders in ordinary experience are generally conceded to be somewhat hard and lacking in roundness. Those in the present series of experiments were typical in that respect. The centrifuged duplicates on the other hand were extremely soft and round, in some instances to so pronounced a degree that they were criticised as being too dead and lacking in point.

In fullness of flavour also the two sets of samples were distinct, the centrifuged liquors being invariably fuller and sometimes so superior in this respect that they could be described as “full bodied,” where their filtered duplicates could hardly be rated higher than “thin.”

Specific Gravity and Acidity Differences.

Table I contains the data of the individual ciders used in these experiments. The ciders were bottled in screw-stoppered bottles and stored in that form at the ordinary cellar temperature until examined in the May and December following.

It will be noted that with the exception of two of the Kingston Black ciders the rates of fermentation were relatively high, thus ensuring that the tests as regards fermentation control and clarification were on the whole somewhat drastic.

The data furnished by the two examinations do not reveal any marked differences between the centrifuged and filtered samples in respect of specific gravity except in the case of Broadleaf Jersey, the phase of yeast inactivation after centrifuging referred to above

having passed before examination. It is nevertheless clear that even for prolonged storage purposes the centrifuge is as efficient a machine as the filter for checking after-fermentation. The racked ciders included in the trials were not typical in their behaviour, since in most years ciders so treated would have fallen below 1.010 in gravity. Probably the exceptionally high original gravities of the juices in 1929 were responsible, fermentation being exhausted before the destruction of the whole of the sugar.

In this connection reference may be made to a trial with a cider made from mixed fruit not recorded in the Table. In this case 30 pipes of this cider were passed through the centrifuge, when the specific gravity had fallen to 1.030. These were kept subsequently for four months at ordinary temperature. During this period hardly any further fermentation occurred, the gravity falling not more than three points in any instance. Untreated control casks of the same cider had fermented completely in the course of two months.

The acidity records of the filtered and centrifuged ciders were considerably less uniform than those of specific gravity. In some cases the filtered ciders were slightly more acid at the end of the tests, but in some instances the difference was in the other direction and at times much greater. There is little doubt that a complicating factor in the form of the action of acid-destroying bacteria has intervened, and that the acidities do not express simply the different effects, if any, of the filter and centrifuge. Thus no conclusions can be drawn on that point at this stage of the investigation. It is expected that further reference to it will be made in a later communication.

GENERAL CONCLUSIONS.

The character of the results described in this paper makes it evident that the application of the centrifuge to cider-making opens up a number of interesting possibilities. One season's experience is insufficient to justify any further claim, but if that is confirmed by future trials and shown to be typical for seasons of varied description, it will mean that the cider maker will have available a method of great utility for fermentation control purposes, and a means of importing an enhanced quality to his product. In that event modern methods of cider-making would probably undergo a revolutionary change.

TABLE I.
Comparative Data of Filtered, Centrifuged, and Racked Ciders.

Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation.	Date of Filtering or Centrifuging.	Specific Gravity at time of Filtering or centrifuging	Specific Gravity May 1930.	December 1930.	
									Specific Gravity	Acid (as Malic) per cent.
Honey Hall Red (23) ..	20/11/29	1.056	0.80	0.22	8.	filtered	1.025	1.021	1.015	0.42
" " " "	" "	"	"	"	"	centrifuged	9/12/29	1.025	1.021	0.39
Pound Apple (49) ..	15/11/29	1.057	0.24	0.13	6.2	filtered	13/12/29	1.025	1.014	0.39
" " " "	" "	"	"	"	"	centrifuged	13/12/29	1.025	1.018	0.24
Sweet Alford (50) ..	21/11/29	1.060	0.27	0.14	4.6	filtered	20/3/30	1.025	1.017	0.28
" " " "	" "	"	"	"	"	centrifuged	20/3/30	1.020	1.018	0.27
Belle Norman (55) ..	23/10/29	1.052	0.33	0.22	5.7	filtered	13/11/29	1.020	1.018	0.30
" " " "	" "	"	"	"	"	centrifuged	13/11/29	1.025	1.017	0.23
Broadleaf Jersey (58) ..	29/10/29	1.057	0.38	0.26	7.5	filtered	12/11/29	1.025	1.023	0.31
" " " "	" "	"	"	"	"	centrifuged	12/11/29	1.025	1.008	0.32
Kingston Black (2) ..	18/11/29	1.061	0.65	0.20	4.2	racked	5/3/30	1.025	1.014	0.44
" " " "	" "	"	"	"	"	filtered	5/3/30	1.028	1.021	0.42
" " " "	" "	"	"	"	"	centrifuged	5/3/30	1.028	1.023	0.39
Kingston Black (5) ..	18/11/29	1.078	0.89	0.24	6.2	racked	13/2/30	1.028	1.023	0.38
" " " "	" "	"	"	"	"	filtered	13/2/30	1.027	1.021	0.93
" " " "	" "	"	"	"	"	centrifuged	13/2/30	1.027	1.021	0.44
Kingston Black (9) ..	19/11/29	1.065	0.67	0.21	2.8	racked	19/3/30	1.027	1.023	0.91
" " " "	" "	"	"	"	"	filtered	19/3/30	1.028	1.023	0.38
" " " "	" "	"	"	"	"	centrifuged	19/3/30	1.028	1.026	0.53
Kingston Black (10) ..	19/11/29	1.061	0.69	0.21	3.2	racked	7/3/30	1.028	1.025	0.45
" " " "	" "	"	"	"	"	filtered	7/3/30	1.028	1.020	0.37
" " " "	" "	"	"	"	"	centrifuged	7/3/30	1.028	1.024	0.36
Bramley's Seedling ..	14/1/30	1.043	0.76	0.08	6.6	filtered	4/2/30	1.028	1.024	0.31
" " " "	" "	"	"	"	"	centrifuged	18/1/30	1.020	1.016	0.54
" " " "	" "	"	"	"	"	"	27/1/30	1.031	1.026	0.51
" " " "	" "	"	"	"	"	"	29/1/30	1.030	1.029	0.41
Mixed Apples No. 1. ..	14/11/29	1.053	0.37	0.22	5.3	"	19/11/29	1.025	1.021	0.45
Mixed Apples No. 2 ..	24/11/29	1.048	0.63	0.21	5.6	"	6/12/29	1.044	1.043	0.40
Mixed Apples No. 3 ..	1/12/29	1.050	0.70	0.32	5.0	"	9/12/29	1.046	1.033	0.35
" " " "	" "	"	"	"	"	"	6/1/30	1.047	1.042	0.63
Mixed Apples No. 4 ..	2/12/29	1.046	0.57	0.12	7.	"	12/12/29	1.035	1.032	0.38
" " " "	" "	"	"	"	"	"	16/1/30	1.042	1.041	0.29
" " " "	" "	"	"	"	"	"	"	1.026	1.024	0.30

THE PREVENTION OF DEPOSIT FORMATION IN PERRIES.

BY O. GROVE.

One of the greatest difficulties in connection with the making and bottling of perry is the tendency of this beverage to develop a dense milky turbidity, which frequently is accompanied or succeeded by the formation of a characteristic heavy deposit. Perries made from most varieties of perry pears are subject to this trouble more or less regularly.

The development and sequence of the changes in a typical case are generally as follows: The perry made during October or November remains, as a rule, perfectly clear after racking or filtering until the following February or March, but thence or some time later it becomes slightly milky in appearance, and this turbidity gradually intensifies. At a later stage the perry often clears, the milkiness condensing by degrees into a more solid aggregate which separates out as a very heavy deposit of a gelatinous nature, and is precipitated on the bottom and sides of the receptacle. This deposit is very voluminous, sometimes half filling the bottle or cask.

Many factors have been mentioned as being responsible for this turbidity and deposit, such as over-ripe fruit, under-ripe fruit, too early making, too late making, etc.

From time to time at this Station experiments have been carried out to find a method to prevent this deposit formation. Many different remedies have been tried without satisfactory results. Last season, however, a treatment was discovered, which completely prevented the formation of deposit in the perries tried. It consists simply in adding to the perry a small amount of sulphur dioxide. This may explain why some makers of perry have always been subject to this trouble and others not. The latter probably have been using sulphur dioxide in some form for cask cleansing or fermentation control, whereas the former have been making their perry without either sulphur-matching their casks, or using sulphur dioxide for fermentation control or preservative purposes.

THE PREVENTION OF DEPOSIT FORMATION IN PERRIES.

Variety.	Date Making.	Specific Gravity of Juice.	Acid %	Tannin %	Date of filtering and bottling.	Specific Gravity May, 1930.	a. Potassium metabisulphite.	b. Potassium metabisulphite.	c. SO ₂ .
Holmer ..	24/10/29	1.067	0.77	0.21	24/1/30	1.030	0.02%	0.04%	0.01%
Blakeney Red ..	24/10/29	1.060	0.57	0.13	16/12/29	1.029	"	"	"
Oldfield 1 ..	26/11/29	1.063	0.65	0.13	27/2/30	1.030	"	"	"
" 2 ..	26/11/29	1.061	0.62	0.11	4/3/30	1.030	"	"	"
" 3 ..	26/11/29	1.063	0.61	0.09	27/2/30	1.029	"	"	"
Huffcap ..	26/11/29	1.063	0.46	0.10	23/12/29	1.028	"	"	"
Butt 1 ..	27/11/29	1.062	0.53	0.39	10/4/30	1.030	"	"	"
" 2 ..	27/11/29	1.057	0.50	0.36	14/4/30	1.030	"	"	"
" 3 ..	27/11/29	1.059	0.53	0.38	15/4/30	1.030	"	"	"
" 4 ..	27/11/29	1.058	0.52	0.38	14/4/30	1.030	"	"	"

The exact chemical nature of the deposit has so far not been determined, and is at present under investigation. A pectic substance is probably concerned, but it does not appear to be a simple pectin derivative, as the following test discovered here in 1905 by Professor Barker indicates. When the deposit is boiled in dilute potash (KOH) in a test-tube, the colour darkens and if the tube is then shaken the film of liquid adhering to the sides of the tube rapidly acquires a vivid purple colour, starting at the upper part of the tube and apparently being an oxidation phenomenon.

The slow formation of the insoluble substance in the perry is possibly due to an enzyme action and, if so, the enzyme must be very sensitive to and inactivated by sulphur dioxide. The conclusions as to the control of this trouble by treatment with sulphur dioxide are based on the following experiments.

On the 5th May, 1930, to a number of perries from different districts there was added, in some cases, potassium metabisulphite and, in others, a solution of sulphur dioxide in water in different proportions. All the perries were perfectly clear at the time.

The perries used were those shown in the Tables.

In each case four bottles were treated by the addition of metabisulphite (containing 55% SO_2) at the rate of 0.02% and 0.04% and sulphur dioxide at the rate of 0.01% respectively. These dosages correspond to 3.2 and 6.4 ounces of potassium metabisulphite respectively per 100 gallons and 3.2 ounces of sulphur dioxide per 100 gallons. Four untreated bottles were kept as controls in each case.

The samples were kept at cellar temperature and examined at intervals during the summer. Slight milkiness started in most of the control samples during the early autumn following.

The samples were finally examined on the 31st December, 1930, with the following results:—

Variety.	Controls.	a. Potassium metabisul- phite. 0.02%	b. Potassium metabisul- phite. 0.04%	c. SO_2 . 0.01%
Holmer ..	Milky	Clear	Clear	Clear.
Blakeney Red ..	"	"	"	"
Oldfield 1 ..	Small lumpy deposit	"	"	"
" 2 ..	" " "	"	"	"
" 3 ..	" " "	"	"	"
Huffcap ..	Slightly milky ..	"	"	"
Butt 1 ..	Thick and milky ..	"	"	"
" 2 ..	" " "	"	"	"
" 3 ..	" " "	"	"	"
" 4 ..	" " "	"	"	"

Analyses of the controls for specific gravity, acid and tannin content were made in comparison with the corresponding treated samples, but no appreciable differences were found. The formation of deposit and milkiness had no influence upon the values obtained for the perries.

Although the treatment has not been tried with all the varieties of pears used for making perry, the above results afford good reason to believe that it may be effective in all cases. If that proves to be so, then this very serious drawback to perry-making can be completely eliminated by the simple addition of a maximum amount of 3 ozs. of potassium metabisulphite per 100 gallons of perry, which is only one half the amount permitted by the Ministry of Health for preservative purposes. Further experiments may show that it may be possible to reduce the addition still further.

APPLE JUICE CONCENTRATES.

BY O. GROVE.

The problem of the profitable utilisation of glut crops of fruit is of long standing, but only of occasional occurrence. The development of improved marketing methods in conjunction with certain other factors has, however, resulted in a regular annual problem of a similar character for apple growers on account of the difficulty of disposing of the not inconsiderable part of the crop which fails to reach the standard market grades.

Several alternative forms of use for this ungradable fruit have been proposed from time to time and most have been given some attention either at the Long Ashton or Campden Research Stations since 1914. The present article is concerned with investigations on types of products which can be classed under the general term of "Juice Concentrates."

During recent years a certain amount of concentrated apple juice has been imported into this country. The concentrate comes mainly from Canada, but Switzerland, France and Germany also have been exporting concentrated juices for some time.

The concentrate has been tried in the cider industry for various purposes. It has been used as a sweetening agent for addition to dry ciders to bring them to the degree of sweetness required to meet commercial demands for a sweeter class of product. It has also been used for conversion into cider by dilution with water and subsequent fermentation. Such cider, prepared by diluting the concentrate with five or six times its volume of water, does not compare favourably with cider made in the ordinary way; but if blended with ciders made principally from bitter-sweet apples, a fairly satisfactory and wholesome beverage of moderate quality can be produced for a cheap trade. In France it is not permissible to apply the name of cider to a drink prepared from concentrates.

Another form of use has been for the production of a non-alcoholic beverage by dilution with water, followed by artificial carbonation. In this case precautions have to be taken to prevent subsequent outbreaks of fermentation, the problems in this respect being similar to those of ordinary sweet forms of aerated waters. The quality

of such aerated unfermented apple juices depends upon the grade of concentrate used, the chief drawback being the element of cooked apple flavour which is invariably present to a more or less noticeable degree in the beverage. With the best type of concentrate this is not unpleasantly conspicuous to the taste.

The ordinary commercial concentrated juice has a specific gravity of 1.26 to 1.32 and contains from 55 per cent. to 65 per cent. of solids, of which about 96 per cent. are sugars. The colour varies in darkness according to the methods used in the making. With a good vacuum evaporator, in which the temperature does not exceed 50 deg. C., the concentrate is of a light reddish-brown colour and no caramelisation of the sugars has taken place. With more primitive evaporates, a dark juice with caramel flavour is the result.

The present investigation has been concerned with three aspects of concentrate production in particular :

- (a) the character of the concentrate obtainable with different classes of apple juice by the evaporation method at a relatively low temperature and under reduced pressure.
- (b) the production of concentrates by a combination of the above evaporation method and the freezing method.
- (c) the production of a special form of concentrate which can be used as a type of treacle.

(a) Concentrates prepared by the Evaporation Method.

The experiments under this head, as with most of those under the other two heads, have been carried out on a relatively small scale under laboratory conditions. The evaporation of the juices was conducted in glass flasks attached to a suction pump and heated by water baths. The temperature of the juices was never allowed to exceed 50 deg. C.

Many kinds of apple juices, with widely differing degrees of acidity have been tested. The concentration has generally been carried to a point where the specific gravity has been increased to 1.32, with an approximate content of sugars of 65 per cent. Under these conditions a product of good colour and appearance has been obtained regularly. The depth of colour, as might be expected, is related more or less closely to the colour of the original juice, the darker types of the latter tending on the whole, to give deep brown concentrates and the lighter types concentrates of a brighter medium reddish-brown shade. For the most part juices from dessert and culinary varieties fall into the latter class and those from the sweet

and bitter-sweet varieties of cider apples into the former. At relatively low temperatures of evaporation a close correlation between the acidity of the original juice and the colour of the concentrate is usually obvious, the most acid juices giving the lighter concentrates and the low acid fruit juices with acidities of about 0.25 per cent. malic acid, giving a product with greater depth of colour. Temperature in this connection is important, since if it is permitted to reach a relatively high point—especially in the later stages of concentration—the more highly acid juices are inclined to caramelise the sugars and the colour is then darkened on that account.

In flavour, no features of special interest nor results not in accordance with expectation, were observed during the experiments. The degree of acidity of the concentrate obviously was directly related to that of the initial juice. In other respects a characteristic apple flavour was retained under the conditions of production already stated, but in no case was the flavour associated with the pasteurisation of apple juice completely unnoticeable, although on the other hand it was not unpleasantly conspicuous.

The results of the various experiments generally indicate that there should be no difficulty in producing an article of that class and quality in bulk with the aid of an efficient evaporator, although the product is likely to be open to some criticism on the score of flavour and inferior in that respect to concentrates prepared without heating.

(b) Concentrates prepared by a combination of Freezing and Evaporation Methods.

The concentration of fruit juices by the freezing out of the major part of the water has been investigated by Gore and others, and also by Monti (Turin) on a commercial scale. The principle on which the method is based is simple. As the temperature of the juice is lowered below 0 deg. C., crystals of pure water ice separate out, leaving the other constituents of the juice in solution in the unfrozen part of the water. By exposure to a freezing temperature for a sufficiently long period, the juice is converted into a semi-solid block, consisting of a mass of ice crystals, the interstices between which are filled with a liquid matrix, which is simply a concentrate of the original juice. By breaking the mass into small fragments and centrifuging, it is possible to separate the concentrate from the ice particles.

Prepared in this way the concentrate is obtained as a thick syrupy liquid, retaining the original fresh aroma and flavour of

the juice unimpaired. In that respect it is definitely superior to the concentrates produced by the evaporation method, these invariably having the original aroma and flavour more or less affected by the heating to which they have been subjected.

By a single freezing it is possible to obtain a concentrate with about 50 per cent. of the original volume of water removed. The percentage of solids in the treated juice is thus approximately doubled. Subsequent freezing of this concentrate by similar treatment can be made to carry the degree of concentration further.

The drawback to the method in this form is the relatively great loss in yield due to the difficulty of removing the whole of the adherent concentrate from the ice crystals. This loss naturally becomes more serious in proportion if the concentrate is refrozen to obtain a more concentrated syrup.

By a combination of this method with the evaporation method, it has been found possible to produce a concentrate superior to that prepared by the latter method only. The procedure adopted was to subject first the juice to a single freezing, as described above, and then to finish the concentration by evaporation under reduced pressure, according to the method described in the previous section.

The product in this case is lighter and brighter in colour and better in general appearance than that obtained by the evaporation method above. The loss in yield is small as compared with that resulting if the complete concentration is effected by the freezing process only. On the other hand the fresh flavour of the juice is lost and the product in that respect approaches that resulting from the evaporation method.

In the case of apple juices, it is doubtful if the improvement in colour adds sufficiently to the value of the concentrate to compensate for the reduced yield and other drawbacks attendant on the use of the freezing process as a part of the procedure.

(c) *Apple Treacle.*

The previous types of concentrates referred to have been pure juice concentrates, prepared simply by the abstraction of water from the original juices by evaporation or freezing, or a combination of the two processes. Dilution with water in quantity equivalent to that removed during the concentration, results merely in a return to the original juice, with such modifications in flavour and other characters as are due directly to the kind of concentration process utilised.

The type of concentrate dealt with in the present section of this

paper is of a somewhat different order. The objective of the experiments was an apple syrup of consistency and sugar concentration similar to an ordinary treacle, to be used primarily for the same purposes as the latter. Dilution with water or soda-water to produce a fruit juice beverage was a secondary and minor consideration. This type of product was especially designed to form an outlet for cull apples of the Bramley Seedling and other highly acid culinary class of varieties, since these, on account of their acidity, do not lend themselves to the production of a high grade of product of the previous class of concentrates considered. Less acid varieties can be utilised for the apple treacle preparation, but in their case suitable adaptations of the acid neutralisation part of the process are required, according to the degree of acidity of their juices.

In most respects the treacle is substantially the same kind of apple derivative as the apple orchard jelly made at this Station during the war (1). The essential difference between the two is that in the former the pectins of the juice are removed to prevent gelling, whereas they are retained in the latter—and where necessary, additional pectin is added—to bring about gel formation. Sometimes in making the apple orchard jelly, failure to get a proper set occurred, and the result then was in essentials, a form of the apple treacle.

Three distinct operations are involved in the manufacture of the treacle: (a) the removal of pectin from the juice; (b) the adjustment of the acidity of the juice to a suitable degree, and (c) the adjustment of the sugar concentration by addition of sugar and subsequent concentration of the sweetened juice.

(a) Unless the pectin of the juice is first removed, the concentrate shows a tendency to form a gel. To prevent this, the juice is allowed to ferment for a few days before starting the evaporation. By this short fermentation changes in the composition of the pectin are brought about and a part of the pectic matter present in the juice is precipitated. The formation of a gel after concentration, does not occur after this treatment.

(b) As the juice from Bramley Seedling and most other culinary apples contains a large percentage of malic acid (0.8—1.3 per cent.), it is desirable to neutralise some of the acid before the concentration of the juice, otherwise the acidity of the concentrate is too high, especially if it is to be used as a treacle. If the concentrate is meant to be used as a beverage after dilution,

it is not necessary to neutralise the acid to the same extent, and sometimes not at all.

For a treacle, it has been found that the acidity in the concentrate should not exceed 0.70 per cent. of malic acid. Consequently the acidity of the fresh juice has to be reduced from about 1 per cent. to about 0.12 per cent. This has been done in different cases with calcium carbonate, potassium carbonate and caustic potash, respectively. Potassium alkalis are preferable to those of sodium for this purpose, partly because of their better flavour and partly because apple juice is already rich in potassium, whereas sodium salts are only present in minute quantities.

- (c) The evaporation should be carried so far that the concentrate contains about 65 per cent. of solids, corresponding to a specific gravity of 1.32. At this concentration the syrup will keep indefinitely under ordinary conditions in completely filled and tightly closed containers. Starting with a juice with a specific gravity of 1.050, corresponding to 12.3 per cent. of solids, it required about 530 lbs. of this juice to produce 100 lbs of a concentrate containing 65 per cent. of solids. Expressed in terms of volume, 700 gallons yield about 100 gallons of concentrate, with 65 per cent. of solids.

To reduce the amount of concentration required, and to improve the consistency of the concentrate and its general character, it has been found useful to add before evaporation a certain quantity of sugar and glucose; the last being added to prevent crystallisation of the cane sugar. By an addition of about 5 per cent. of sugar and 5 per cent. of liquid glucose, a better colour is obtained, the concentrate has a more "treacly" consistency, and it is not necessary to carry the concentration so far. From an economic point of view the addition of sugar and glucose is also advantageous.

Prepared along the lines of the method described, apple treacle is a product of a fairly distinctive character, suitable for the same uses as ordinary molasses treacle, superior in flavour and of a higher nutritive value. Sufficient data are not yet available to justify any comparison between the two on the economic side, and until the apple product has been tested commercially under more normal conditions, a fair market value cannot be attached to it. It would appear, nevertheless, to be an article with some commercial possibilities, particularly if cull apples continue to be obtainable in quantity at the average price of cider fruit or less.

THE PRODUCTION OF CRICKET BAT TIMBER.

BY H. P. HUTCHINSON.

At the present time there is a shortage of willow timber suitable for the making of cricket bats. This shortage is due to a considerable extent to the increasing popularity of the game whereby there is an increasing demand for bats both at home and abroad. In 1930 bat willow timber sold at 21/- per cubic foot standing, but it is essential if this high price is to be realised that the timber should conform in character to the bat makers' requirements in being straight in the grain, uniform in texture, tough, of a suitable weight relative to its volume and white in colour.

The following information, which has been collected from various sources, may be helpful to growers for the production of timber of good commercial quality.

The factors which determine timber quality are, to a great degree, controllable and may be considered under the following headings :—

Variety.

The English willows—*Salix alba*, *S. fragilis*, varieties and hybrids of these species—possess characters in their timbers which render them all suitable for bat making, but in varying degrees. The true cricket bat willow—*S. alba* var. *Caerulea*—is so superior to the rest as to justify its being planted not only for the production of bat timber but for all economic purposes in preference to any other variety of tree willow. The present scarceness of *Caerulea* trees is, in the main, due to the fact that in the extensive plantings which have taken place during the last twenty-five years many thousands of other varieties have been substituted for it. This misfortune has arisen chiefly as a result of ignorance on the parts of both buyers and sellers of the sets, and to a great extent is excusable because sets of *Caerulea*, whether long or short, are indistinguishable in their botanical characters from sets of several other tree varieties. In the first case, therefore, the planter should take the utmost care in assuring himself that all his sets have been obtained from a reliable source.

The Set.

The set consists of a rod from which the side branches have been removed. It should be from 12 to 15 feet in length, straight and sufficiently rigid to maintain a vertical position after planting without the aid of a stake. Rods of one year's growth are frequently of the required length, but if used as sets are too supple to withstand wind pressure without bending. In such cases the tree is deteriorated in value on account of curvatures which arise in the bole. Rods of from two to four years' growth are satisfactory. The best sets are produced from willow trees which have been pollarded when in the prime of growth or from short cuttings which have been specially planted in the nursery for the production of long sets. One-year-old sets from 4 to 10 feet in length are sometimes planted. Although such sets root readily, they, in contrast with the longer, stouter sets, have the disadvantages of being more subject to injury by wind and animal attacks, and in requiring considerable attention in staking and in securing a sufficient length of straight bole. Sets which have been allowed to root in the nursery for a year or two, so becoming young trees, are sometimes planted, but under equal growth conditions the presence of the root does not appear to give any advantage in growth over the unrooted set.

A crooked set is objectionable because permanent wood curvature is set up and the timber is not straight grained. The presence of a kink in the set results in an uneven distribution of wood in its neighbourhood which may persist throughout the lifetime of the tree. In such cases the clefts into which the logs are split are curved on their inner faces, the result being that excessive waste of timber occurs in the later stages of manufacture. It is the trunk of the tree only which is required by the bat maker, the upper parts being discarded. As the best timber is contained in the lowest part of the bole, it is good policy for the grower to arrange that the tree shall form the maximum amount of wood as near the ground as circumstances will permit. The bat maker is suited when he can obtain 4 bat lengths, *i.e.* 4 sets of clefts each 29-30 inches in length between ground level and the primary branches. With this requirement in mind sets 12-15 feet in length would ultimately form trees of the desired bole size, 2 feet to 2 feet 6 inches of the set being in the ground, 10-12 feet forming the clean trunk and bases of the main branches. Sets, 20 feet or more in length, are sometimes planted. These develop into "poley" trees, which contain a larger proportion of upper inferior timber than corresponding trees of the bole length recommended. Nor do they have the advantage of yielding a greater total weight

of bat wood ; it may be less owing to the waste of timber due to the many short branches which easily escape notice when they first arise.

Soil Conditions.

The only criterion of the value of any soil for bat willow production is the rate at which it is capable of producing mature trees, the two terms being directly proportional. Judging from observations, the soil should be rich in plant food and the water supply should be adequate. When favourably placed the willow develops an extensive root system. Rootlets develop as finely divided matted masses in running water so forming an extensive water-absorbing organ. Evaporation is correspondingly provided for in the leaves which, by being numerous, thin and having stomata on both sides, form a large evaporating surface. The state in which the water exists in the neighbourhood of the roots is of the greatest importance. A bat willow tree will continue to live many years, but will not thrive, on waterlogged land. A running stream with open textured well-drained soil affords the best conditions for rapid growth. Many types of soil, grading from gravels to marls, conform with these requirements. Suitable sites are to be found on the banks of streams, the margins of ponds, lakes and wet areas. The distances between one tree and the next should be from 25 to 30 feet. The best timber is obtained from trees growing in single line or as narrow belts. Growth is less satisfactory when the block system of planting is adopted. The trees growing in the inner parts of such plantations are frequently inferior to those on the outsides, a result of inadequate drainage at these places. Sewage farms produce first-class bat willows where the soil medium is rich and large quantities of water are kept in a state of motion. Many areas could be made more suitable for bat willows if steps were taken to secure a more rapid removal of water by the construction of surface drains.

Attention during Growth.

During the first summer after planting the set develops roots and shoots. As the motion of the young plant due to wind action is liable to cause an opening to appear in the soil around the base of the stem whereby young roots become broken, frequent inspections are necessary. Any gaps which appear should be closed by pressing the soil back firmly. Many buds will arise throughout the length of the stem. The general recommendation now is that these buds should be rubbed off to a height of 11 feet as soon as

they appear. Experiments at this Station have shown that the presence of lateral shoots during the first year is advantageous in increasing the rate of growth of the plant as a whole, including thickening of the stem, but this practice cannot be recommended because it is not yet known what the after-effects on the wood will be. It is possible that the presence of the scars caused by the pruning of the lateral shoots at the end of the first year may have such a pronounced and lasting effect through subsequent uneven wood formation as to seriously impair the value of the timber.

The set is subject to very severe damage by ground game and farm stock. Rabbits and hares gnaw the bark, causing severe injury or death. The use of deterrent preparations smeared on the bark or the fixing of a collar of wire netting about 3 feet in depth close to the stem has been found to be satisfactory in affording adequate protection against these pests. The latter method is also satisfactory against gnawing and rubbing by sheep. Cattle and horses if allowed access to the trees will cause great damage by eating the tops. A fence consisting of a single strand of barbed wire and posts is sufficient for protection in this case.

Buds will continue to develop on the stem for the first three or four years following planting, but the number gradually diminishes as true bark develops. They should be rubbed off as soon as observed.

The Use of Fertilisers.

Bat willow growers know the importance of securing the greatest rapidity of growth of their trees and requests are frequently made by them for advice on the use of fertilisers. As no experimental work on the subject has yet been carried out as far as tree willows are concerned, direct advice is not obtainable, but reasoning from the analogous case of basket willows, on which a considerable amount of research and experimental work has been done, it may be inferred that the application of nitrogenous and phosphatic manures would be valuable. This inference is supported by evidence afforded by trees grown in situations where organic matter is plentiful, such as Sewage Farms and sites near farmyard manure heaps. The method of application of fertilisers would depend on the particular location of the trees. In most cases, in order to obtain full advantage of the fertilisers applied, it would be necessary to remove the vegetation for a distance of two or three yards from the base of the trees, to dig the surface and to apply the manure in the early spring.

Maturity.

A bat willow is ready for sale when, at 5 feet above ground level, the quarter girth is $8\frac{1}{2}$ inches. In favourable situations this size is reached in 12 to 15 years from the date of planting, but cases are known where, owing to particularly favourable conditions, the required size has been attained in 9 years, which means that, starting with a set of $1\frac{1}{2}$ inches in diameter, a layer of new wood over $\frac{1}{2}$ inch in thickness has been added annually.

The following information is extracted from growth records of 6 bat willow trees now growing on the Experimental Willow Plots of the Research Station, Long Ashton :—

GIRTH MEASUREMENTS IN CENTIMETRES TAKEN AT 5 FEET ABOVE
GROUND LEVEL.

Tree No.	1928. Planting Date.	1928.	1929.	1930.
	April 3.	Nov. 17.	Nov. 13.	Oct. 28.
1	13.3	15.6	19.4	24.5
2	13.5	15.5	19.6	24.1
3	14.1	15.8	21.4	26.7
4	14.1	15.4	20.5	25.8
5	12.4	15.2	23.3	33.5
6	14.9	16.7	24.6	35.3

The trees are growing on a bank at the foot of which is a small stream, generally dry in summer. The distances apart are 20 feet. The trees Nos. 5 and 6 were planted near the site of an old manure heap. If the rates of growth hitherto made be maintained, trees Nos. 1 to 4 and Nos. 5 and 6 will be large enough for cutting in 17 and 11 years respectively from the date of planting.

REPORT ON ADVISORY WORK, 1929-30.

The number of advisory enquiries received during the year under review shows a large increase over the number received for the previous year, and serves further to demonstrate the rapid growth of the advisory activities of the Department which has continued during the post-war period. The increase in the present case has not been confined to one special subject, but no less than five subjects show substantial increases in the numbers of enquiries received, viz.: Agricultural Chemistry, Pomology, Entomology, Mycology, Disease Control Materials and Methods. The increase in Pomology is due to the increased number of enquiries relating to the pomological work of the Long Ashton Institute; in Entomology a large proportion of the enquiries is in connection with two special subjects, strawberry diseases and tar distillate washes, and many of the enquiries come from sources outside the Bristol Province; in Mycology the advisory work has been developed during the year by the appointment of a special officer to investigate diseases of vegetable crops, and this has led to a substantial increase in enquiries; enquiries relating to disease control materials and methods have increased greatly during the year in connection with the special investigations relating to spray fluids in progress at Long Ashton.

The following table gives the number of enquiries submitted during the last six years :—

	Year ending September 30th.					
	1925	1926	1927	1928	1929	1930
Gloucester (including Bristol) ..	194	262	183	202	193	301
Hereford	88	91	115	97	115	136
Somerset	395	276	254	308	300	440
Wiltshire	117	175	104	104	139	136
Worcester	78	103	168	161	136	244
Other Areas	222	309	478	495	721	1025
	1094	1216	1302	1367	1604	2282

Included in the figures under "other areas" are enquiries received from Devon and Monmouth, both of which contribute annual grants to the Long Ashton Institute, and from Dorset, which participates in the Scheme for Local Instruction in Cider-making. None of these counties rank officially as part of the Bristol Province.

This list does not indicate the very numerous enquiries dealt with in personal interviews during survey work, local investigational work, shows, etc., nor those relating to fruit and vegetable preservation and products, which have been dealt with up to the present time by the Campden Station. Also, as in previous years, no figures for enquiries received under the heads of Agriculture, Economics or Dairy Bacteriology have been included, so that the statistics given may be comparable with those of earlier years before those subjects were dealt with.

Special attention should be directed to certain items in the sectional reports which follow.

The Longleat Grazing Experiment has been continued and the manuring of certain of the intensively grazed plots was again made possible as the result of grants from the Bath and West Agricultural Society and the Wiltshire County Council. The data so far obtained indicate that manuring the intensively grazed plots materially assists the herbage in withstanding the effects of drought. The experiment is to be continued for another season.

A number of samples of herbage have been analysed for iodine content. Whilst work is still in progress, the results available demonstrate the large differences which may exist in the iodine content of herbage from the same area—figures from 6.4 Y's to 177.7 Y's being recorded ($Y = 0.000001$ gram).

Manurial and cultivation trials in connection with the growing of flax (for fibre production) in the West of England were established in the spring of 1930. The effect of nitrogen on the colour and health of the crop was very marked at nearly all the centres.

A farm account book has been issued by the Department and the use of this book by farmers submitting accounts for analysis has very much simplified the work of the farmer and of the Department. Nearly all the work in advisory economics is in connection with ordinary farms. Only about 2 per cent. of the enquiries received have come from fruit growers and market gardeners.

The work of the Dairy Bacteriologist has increased to a very marked extent. In addition to the usual routine in connection with "clean milk" samples, the Bacteriologist has visited 30 farms and examined nearly 1,000 samples of milk for advisory purposes. The Department is investigating the problem of high counts in milk presumably due to the high temperature of the milk during transit in the summer.

The number of enquiries received in Entomology was extremely

large, viz. : 530, and of these 236—approximately 45 per cent.—were from sources outside the Province. The majority of the enquiries related to problems of strawberry culture and the use of tar distillate washes, subjects to which the adviser has given special attention during the past few years.

The adviser in Mycology has undertaken a number of special investigations in connection with vegetable crops in the larger market gardening areas of the Province, notably the Evesham, Pershore, Cheltenham and Bristol areas. He has been assisted in this work from January 1st, 1930, by a special officer, and the appointment of this officer has led to considerable development of the work. The activities of the adviser and his present colleague, Mr. B. O. Mulligan, in these investigations are reflected in the large increase in the number of enquiries relating to the subject.

In previous years enquiries relating to Disease Control Materials and Methods have been included under Entomology and Mycology, but the numbers received under this head have recently grown to such dimensions as to merit a special section in the report. The increase is due to the special investigations which have been in progress at the Long Ashton Station during the past few years relating to spray fluids, and especially to winter washes, and which have led to important practical developments during the past two or three seasons.

As a result of the work large numbers of enquiries have been received from spray fluid manufacturers and intending manufacturers of washes relating to the new types of washes, and from growers in connection with the special properties of the fluids and methods of using them. In this case also a very large proportion of the enquiries came from sources outside the Bristol Province, viz., 190 of a total of 224.

The feature of the advisory work for the year on willows was the successful introduction, by the Long Ashton Station, of a willow peeling machine to the willow-growing industry. A demonstration of the machine, which was attended by the chief willow growers of the country, was given in Somerset by the French makers.

The subjects covered by the Advisory work of the Department are Agriculture, Agricultural Chemistry, Agricultural Economics, Dairy Bacteriology, Cider and other Fruit Products, Pomology, Horticultural Chemistry, Economic Entomology, Economic Mycology, Disease Control Materials and Methods, and Willow Growing. The salient features of the work under each of these during the year are summarised below.

AGRICULTURE.

The work on grass land improvement mentioned in previous reports has been continued. The Chief Advisory Officer, who is responsible for this work in the Bristol Province, has again also taken an active part in grass land schemes in other parts of the country.

Agricultural Chemistry.

295 requests for advice were received and 807 samples were analysed in connection with these enquiries.

The main investigations in progress or completed during the year were as follows :—

(1) *Grass Land.*

- (a) *Longleat Grazing and Manuring Experiments.* The analysis of grass samples from the experimental plots at Longleat was continued. This experiment is being partially financed by the Bath and West Agricultural Society. Valuable field and laboratory data are being collected over a number of years.
- (b) *The Iodine Content of Pasture Grass.* This work is being conducted in collaboration with the Rowett Research Institute.
- (c) *The Eradication of Slender Foxtail (Alopecurus agrestis).* These experiments which were being carried out by the Advisory Chemist and the Agricultural Organiser for Wiltshire have now been completed, and the results published in the Journal of the Ministry of Agriculture, January 1930.
- (d) *Development Commission Pasture Experiments.* Two experiments in connection with the National Scheme of Experiments are under the control of the Advisory Chemist, and three-weekly samples of the herbage have been collected throughout the season for analysis.
- (e) *Nutritive Value of Pasture Grass.* Upwards of 700 samples of pasture grass and hay have been collected from different centres in the Province during the past four years. These samples are being subjected to complete analysis in order that their feeding value may be assessed.

- (f) *Eradication of Bracken.* These experiments, which have been carried out for the Experiments Committee of the Bath and West Agricultural Society, and which have been in progress since 1921, have now been completed. The final report appears in the Journal of the Bath and West Society for 1931.
 - (g) *The Destruction of Moles.* The work has now been completed and a bulletin on the subject has been issued by the University. This bulletin is obtainable gratis on application.
- (2) *Arable Land.*
- (a) *The Manuring of Flax.* At the request of the Ministry of Agriculture, the Advisory Chemist was asked to arrange for the establishment of Flax Manurial Trials. Accordingly, centres have been established in the counties of Somerset, Wiltshire and Dorset (in collaboration with the Reading Province).
 - (b) *Mixed Corn Crop Trials.* A series of winter and spring sown mixed corn crop trials have been established in the Bristol Province. Representative samples of the thrashed material (which is to be used for home consumption) are being analysed at Bristol.
 - (c) *Seeds Mixture and Clover Trials.* These are being continued.
 - (d) *Mole Drainage Experiments.* These experiments are being conducted in order to trace the effect of mole drainage on soil texture.
 - (e) *Sugar Beet Experiments.* Simple variety trials are being conducted.
 - (f) *Liming Experiment.* One large scale trial has been established in the Province.

Agricultural Economics.

The advisory work in Agricultural Economics has increased considerably during the past year, so that, at the present time, over 200 farmers from all the counties of the Bristol Province are submitting their accounts for analysis and report. The work involved in preparing and examining these accounts has been made easier, both from the point of view of the farmer and the Economist, by the use of a farm account book, which has been issued by the Department. Nearly all the work in advisory economics has been

in connection with ordinary farms, only about 2 per cent. of the enquiries being received from fruit growers and market gardeners. It is hoped to extend this side of the work if circumstances permit.

Investigations in progress may be summarised as follows:—

- (a) *Costing*. These investigations are in progress on nine farms, comprising 2,148 acres.
- (b) *Financial Accounts*. 235 farms, comprising 93,708 acres, are included in this work. The farms may be classified according to type. viz: 189 mixed, 30 milk producing, 13 cheese-making, 2 market gardening, and 1 fruit.
- (c) *Cost of Production of Sugar Beet*. This work, which was conducted in collaboration with the University of Oxford, has been concluded.
- (d) *Statistical Methods*. Work concerning the application of statistical methods to farm account data has been commenced with a view to establishing a possible method of farm classification.

DAIRY BACTERIOLOGY.

899 samples of milk were examined in the course of advisory work, and a total of 4,128 samples in connection with the whole of the activities of the Dairy Bacteriologist.

Clean Milk Competitions.

The Department has again co-operated with the counties concerned in the following Clean Milk Competitions:—

- (a) *Gloucestershire*. Three classes for competitors, of six months' duration, commencing January 1st, 1930.
- (b) *Somerset*. Competition confined to cheese-makers, of six months duration, commencing February 1st, 1930.
- (c) *Worcestershire*. Three classes for competitors, of six months' duration, commencing January 1st, 1930.
- (d) *Wiltshire*. No actual Clean Milk Competition, but the Register of Accredited Milk Producers, referred to in a previous report, was continued for the whole of the year and is still in progress.

The Dairy Bacteriologist has commenced an investigation into the practicability of using some form of insulated box for the transit of milk samples, particularly during hot weather.

A study is also being made of thermophilic organisms in milk.

CIDER AND OTHER FRUIT PRODUCTS.

401 enquiries, including 141 under the Cider Instruction Scheme in the counties of Dorset, Monmouth and Worcestershire, received attention.

Among the general enquiries, many received from fruit growers related to the possibility of utilising culinary varieties for cider-making in conjunction with low-acid sweet and bitter-sweet types of cider varieties.

The Instructor paid special attention to the following points in his counties.

Bottling of Cider. Further experiments were carried out with a view to examining local supplies of apples for making high grade bottled ciders.

Filtering. Demonstrations of filtering were continued on farms, since this process is of great importance in the production of high-grade ciders.

Disorders of Cider. Cases of cider disorders have been carefully investigated as they occurred, and methods of overcoming certain of them have been demonstrated.

Orcharding. Further records on the trial cider orchards were collected during the season.

POMOLOGY.

263 enquiries under this head were received, of which 140 were from districts outside of the Bristol Province.

The enquiries covered a very wide field, relating to almost every phase of fruit growing practice.

Special investigations were continued as follows :—

1. Pomological surveys in conjunction with soil survey work in the Evesham, Pershore and Cheltenham areas.
2. Sub-soiling investigations in connection with the bad effects of impervious subsoils on the growth of fruit trees.

HORTICULTURAL CHEMISTRY.

72 enquiries, including 36 from centres outside of the Bristol Province, were received.

Investigations were continued on the following points :—

1. Manuring of fruit trees, bush fruits and vegetable crops.
The experiments on the two former had special reference

to the use of potassic and nitrogenous manures. In the vegetable experiments the trials were in connection with asparagus "sickness." Potash deficiency appears to be an important factor in this problem in the Evesham area.

2. Survey of Soils in the Fruit and Market Garden Areas on the Lower Lias Formation around Evesham, Pershore and Cheltenham. Soil maps on a textural basis have been prepared for these areas.

ECONOMIC ENTOMOLOGY.

The number of enquiries received during the year was 530, of which number 236, relating to work on tar-distillate washes and problems connected with strawberry growing, were received from outside the Province.

The main investigations carried out were as follows :--

Winter Sprays. Extensive field trials were again arranged, at five centres, with the aid of a special grant from the Ministry of Agriculture and Fisheries. A wash consisting of a mixture of high-boiling neutral tar-oil and heavy petroleum was included in the trials for comparison with the "two-solution" high neutral tar-oil wash. The former has proved itself to be exceptionally effective in the control of Capsid Bug on black currants. It also gives promise of controlling red spider in the egg stage. The tar oil-heavy paraffin wash also gives a high control of the other insect eggs controlled by the "high neutral" wash.

Apple Sawfly. Trials were made in the control of this pest by means of spraying at blossoming and a week after the petals had fallen. The sprays employed were nicotine and Pyrethrum. Whilst some measure of control was obtained with later sprayings, it is felt that the correct time for spraying for this district has yet to be determined.

Strawberry Problems. Plots which have been laid down at Cheddar, to demonstrate the work on strawberries carried out at Long Ashton, are proving satisfactory. The plots are run in collaboration with the Horticultural Instructor for Somerset.

Use of Naphthalene on Carrots and Potatoes. Further experiments with crude naphthalene and fractions of the oils contained therein have been carried out against Carrot Fly and Potato Eelworm. Results with the latter were not of a promising nature.

Beet Carrion Beetle. Results obtained in a small trial carried out in Gloucestershire show that lead arsenate dust effects an efficient control of this pest.

ECONOMIC MYCOLOGY.

The number of advisory letters despatched during the year was 299, an increase of almost 90 per cent. on the previous season. The chief subjects of investigation were as follows :—

1. *Diseases of Fruit Trees.* Field control of apple mildew by means of dusts ; studies of apple die-back, associated with *Cytospora* *sp.* ; apple fruit rots, especially that caused by *Phytophthora Syringae*, and the so-called "Allington Spot ;" *Botrytis cinerea* on cherries ; die-back of black currants, associated with *Diaporthe perniciosa* ; strawberry diseases generally, and the strawberry leaf-spot and fruit-spot caused by *Septoria Fragariae*.
2. *Market Garden Crops.* Investigations relating to the more serious diseases occurring in the important market garden areas in the province were continued. The subjects receiving special attention were asparagus diseases, footrot of dwarf beans and peas, and vegetable marrow mildew.
3. *Ornamental Plants.* Work was carried out on a *Fusarium* bulb rot and wilt of early-flowering gladioli ; freesia diseases generally ; the control of *Fusarium* wilt of carnations and *Fusarium* wilt of China asters.
4. *Miscellaneous.* A further survey of hop diseases was carried out. Downy mildew was apparently absent from the Province during the year.

The *Melampsora* rusts of basket willows were fully investigated.

DISEASE CONTROL MATERIALS AND METHODS.

224 enquiries relating to these subjects, of which 190 came from outside of the Bristol Province, were received.

More than half of the enquiries were from manufacturers or intending manufacturers of winter washes of the tar-distillate type, and many others were from growers in connection with the use of this class of spray fluids.

Several enquiries related to the subject of Pyrethrum products and the use of Pyrethrum washes as insecticides.

WILLOW GROWING.

198 enquiries were received regarding problems connected with willow growing, the chief being concerned with :—

The Control of Insect and Fungus attacks.

Manurial Treatment of the Crop.

Soil and Variety problems.

Peeling of Willows.

The Cultivation of the Cricket-bat Willow.

Field trials on the use of fungicides and insecticides were carried out on commercial willow beds in Somerset, from which useful information for future and more effective work was obtained.

Manurial experimental plots are being arranged for 1931.

Considerable interest has been shown by Somerset Growers in the growing of the Cricket-bat Willow, owing to the present high price of cricket bat timber. As many suitable sites for bat willows exist in the area, extensive planting may be expected.

The Somerset County Council willow trial beds have served a useful purpose in enabling growers to select varieties suitable for their requirements.

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